UNIVERSITY OF OKLAHOMA
GRADUATE COLLEGE

DO PERCEPTIONS OF INSTRUCTORS' EFFECTIVE FEEDBACK PREDICT MATHEMATICS STUDENT GROWTH MINDSET, SELF-EFFICACY, AND ACHIEVEMENT GOALS?

A DISSERTATION
SUBMITTED TO THE GRADUATE FACULTY
in partial fulfillment of the requirements for the
Degree of
DOCTOR OF PHILOSOPHY

By
Maria Idrees
Norman, Oklahoma
2026

DO PERCEPTIONS OF INSTRUCTORS' EFFECTIVE FEEDBACK PREDICT MATHEMATICS STUDENT GROWTH MINDSET, SELF-EFFICACY, AND ACHIEVEMENT GOALS?

A DISSERTATION APPROVED FOR THE
DEPARTMENT OF EDUCATIONAL PSYCHOLOGY

BY THE COMMITTEE CONSISTING OF

Dr. Michael Crowson, Chair

Dr. Benjamin Heddy

Dr. Maeghan Hennessey

Dr. Lara Mayeux

Acknowledgments

First and foremost, I would like to express my deepest gratitude to Allah Almighty for giving me strength, patience, guidance, and persistence to complete my PhD journey. Without His blessings and mercy, this achievement would not have been possible.

I would like to say my sincere and heartfelt appreciation to my advisor, Dr. Crowson, for his continuous supervision, guidance, encouragement, and support from day first to throughout this journey. Thank you so much for guiding me at every step of this process, for your patience, and for always remaining calm, understanding, and supportive during challenging times. Your mentorship has been a central part of my academic, professional, and personal growth. Words are not enough to say but I am deeply thankful to you for everything you did in my support. It means a lot to me.

I would also like to sincerely thank my incredible committee professors Dr. Hennessey, Dr. Heddy, and Dr. Lara for their valuable guidance, constructive feedback, and support during all this journey. I am lucky to have such amazing PhD committee members whose insights and recommendations greatly strengthen this work and contributed to my learning experiences. Thank you so much for being a valuable part of this whole process. My sincere thanks would also go to all other professors who taught me throughout my PhD. I have learned so many things from different courses which were helpful to complete this dissertation.

I am deeply grateful to my friends, especially Muhammad Asif for encouraging me to pursue my PhD from such a prestigious institute and his continuous support in so many ways. Your support is the biggest reason for me to stay persistent and believe in my strengths. I would also like to say thanks to my dear friends like sister Candace Andrews, Nida Khan, Asra Fathima, and Aqsa Mushtaq for your encouragement, support, kindness, always being around whenever needed and Nida Khan thank you for taking care of my son like yours while I was so stuck in my work. All of your presence and encouragement made difficult moments easier and more manageable.

Heartfelt gratitude to my family, especially my parents and siblings, for believing in me, supporting my dreams, and encouraging me to continue pursuing my goals. Your prayers, sacrifices, and trust in my abilities have always been my source of strength and important of achieving this milestone.

A very special thanks goes to my brother, Muhammad Shahbaz. Your trust in my abilities, your support since I started my education, the sacrifice you made for all your sisters including me all had a profound impact on my life and educational journey. Where I am today, you are one of the biggest reasons behind it. Thank you so much for being an incredible brother and thank you for your support.

To my husband, Muhammad Asim, thank you so much for being an incredible source of support throughout this entire process. Thank you for taking care of our son while I was studying and working, thank you for adjusting your schedule according to mine, thank you for always encouraging me during my stressful time. Your patience, understanding, and support made this journey possible.

My beloved son, Taimoor Asim, you have been such a calm, loving, and wonderful baby since the day you were born. Even though you are only two and a half years old, you have been so understanding throughout this journey. I am deeply thankful to you for your patience, love, and the happiness you brought into my life during the most challenging times of this PhD journey. Your mama is sorry for not always being as available as you may have wanted, but every sacrifice and every late night was for a better future for us. I hope that one day you will feel proud of your mama and understand how much your love and presence gave me strength to keep going. You are one of my greatest blessings and my biggest source of motivation.

I would also like to express my sincere gratitude to Dr. Wao Felix and Christina Smith for being such supportive and understanding supervisors at my workplace. Your consistent flexibility, encouragement, and kindness have been a great help. Thank you for always being accommodated during demanding times, which helped me balance both my professional and academic responsibilities successfully.

Lastly, I wanted to thank myself as this journey was not easy. There were many challenges, struggles, sacrifices, and moments of self-doubt along the way. But I continued moving forward with determination and resilience. Completing this PhD is a reminder of my strength, persistence, and growth.

Dedications

I dedicate this dissertation to my son Taimoor Asim for constant inspiration and love.

Abstract

The purpose of this study was to examine whether undergraduate mathematics students' perceptions of their instructors' effective feedback practices predict their achievement goals orientations through the mediating roles of mathematics growth mindset and self-efficacy. Based on different motivational theories and empirical evidence, the current study investigated how students' perceptions of effective feedback related to motivational beliefs and achievement goals in mathematics contexts. A quantitative correlational research design was used to examine survey data collected from ($N = 1405$) first year undergraduate mathematics students enrolled in MATH 1005 (Mathematical Reasoning) and MATH 1643 (Foundation and modeling) courses at Midwest University. Assessment measures used to collect data included perceived effective feedback scale, mathematics growth mindset scale, and approaches to learning scale for measuring achievement goals and self-efficacy. Path analysis was conducted to investigate the hypothesized relationships among study variables. Findings indicated that students' perceptions of instructors' effective feedback positively predicted both mathematics growth mindset beliefs and self-efficacy. Mathematics growth mindset positively predicted mastery goals while negatively predicting performance approach and performance avoidance goals. Self-efficacy positively predicted mastery and performance approach goals and negatively predicted performance avoidance goals. Additionally, mathematics growth mindset and self-efficacy significantly mediated the relationships between perceived effective feedback and achievement goal orientations. These findings contribute to the existing literature on feedback, motivation, and mathematics education by focusing on the importance of students' perceptions of instructor feedback in determining students' motivational beliefs and achievement goals within undergraduate mathematics contexts.

Table of Contents

Chapter 1: Introduction

Student motivation and achievement are central concerns in education, as they influence learning outcomes, persistence, and long-term academic success. Over the past few decades, students' beliefs about the malleability or stability of their intelligence/abilities have been a focus of the researchers' community in educational psychology (Burnette et al., 2020). Entity beliefs means that an individual believes that their intelligence is fixed and stable and cannot be improved, while incremental beliefs mean that individual beliefs that their intelligence is malleable and can be improved (Dweck & Leggett, 1988). A growing body of research has suggested that students' self-beliefs about the malleability or stability of their intelligence/abilities i.e., growth and fixed mindsets are a powerful predictor of their learning and achievement motivation (e.g., achievement goals) (Chen & Pajares, 2010; Dweck & Leggett, 1988; Hardre et al., 2007; Yeager & Dweck, 2012).

The achievement goals play a central role in shaping students' motivation, self-regulation, engagement, and overall academic performance, making them a key focus in educational research (DeBacker & Crowson, 2006; Elliot & McGregor, 2001; Senko et al., 2011). Students' beliefs about intelligence whether viewed as fixed or malleable as well as their self-efficacy, are particularly influential in determining the types of achievement goals they adopt (Daumiller et al., 2016; Dweck & Leggett, 1988; Hardre et al., 2007; Schunk, 2003). In addition to these students' personal factors, teacher-related factors also have been consistently found to play a critical role in shaping students' achievement motivation. Among all these factors, feedback stands out as especially powerful because it conveys implicit beliefs about ability, efforts, and significantly affect students learning and motivation (Hattie, 2009; Hattie, 2024; Hattie & Timperley, 2007; Koenka et al., 2021; Muenks et al., 2020; Shute, 2008; Winstone et al., 2017).

Teachers' feedback, whether effective (focusing on effort, strategies, and progress) or ineffective (emphasizing outcomes) profoundly shape students' academic beliefs and achievement motivation (Hattie & Timperley, 2007). Through feedback teachers' essentially give information about the students' performance or learning with the aim of reducing the gap between students' understanding and their actual performance with clear suggestions to improve (Hattie, 2009). As feedback is an important component of instructive practices which link the teachers' teaching practices to students' learning needs but about a third of the reported effects of feedback on students' learning found to be negative (Brookhart, 2017; Kluger & DeNisi, 1996; Roels et al., 2010).

Apart from that, different types of feedback (effective vs. ineffective) seemed to have different effects on students' learning with effective feedback noted to improve students' learning and ineffective feedback reduce the intrinsic motivation and desire of learning among students (Hattie, 2003; Hattie, 2012; Thurlings et al., 2013; Wiggins, 2012). Although teachers often report providing extensive feedback, the critical issue lies in how students perceive and report that feedback and how it influences their subsequent actions (Hattie, 2003). When feedback is perceived as ineffective, students often experience frustration, which can trigger negative cognitive processing and negatively affect learning (Lipnevich & Smith, 2022). Therefore, the perception of the feedback receivers (students) plays a crucial role in the feedback process and outcomes (Lipnevich & Smith, 2022). Interestingly, relatively few studies have specifically examined how students perceive feedback and how these perceptions shape their various learning outcomes. More importantly, fewer studies have focused on students' reports (perceptions) of how frequently instructors demonstrate behaviors that are theoretically and empirically recognized as characteristics of effective feedback, such as process-oriented comments, opportunities for revision, and constructive guidance for improvement (Harks et al., 2014; Rakoczy et al., 2013; Strijbos et al., 2010).

Moreover, students are often viewed as central agents in the feedback process with research indicating that students' perceptions of how frequently instructors demonstrate behaviors consistent with effective or ineffective feedback can significantly be different depending on both situational (e.g., classrooms, majors etc.) and individual factors (e.g., self-efficacy, mindset beliefs) (Havnes et al., 2012; Lipnevich & Smith, 2022; Rakoczy et al., 2013). Additionally, studies also suggest that students' interpretations for feedback differ according to their achievement level. Those experiencing academic difficulties often favor summative feedback, whereas higher-achieving students tend to prefer formative feedback that promotes further progress (Berry et al., 2025).

Keeping in mind the importance of feedback on students' learning outcomes and motivation, the current study focuses on undergraduate mathematics students' perceptions of their instructor's effective feedback practices. The aim of current study is to find out the impact of perceived teachers effective feedback practices on students' achievement motivation through students' math growth mindset and self-efficacy. Importantly, perceptions of effective feedback in this study do not refer to students' subjective evaluations of whether their teachers' feedback is good or bad. Rather, they refer to students' reports of how frequently instructors demonstrate behaviors that are theoretically and empirically recognized as indicators of effective feedback (e.g., process-oriented comments, opportunities for revision, constructive guidance for improvement). This focus is particularly important because mathematics students are often found to hold negative perceptions of their own mathematical abilities, shaped by a complex interplay of factors such as personal mindset beliefs, self-efficacy, teacher practices, parental expectations, and culturally embedded gender biases (Ayotola & Adedeji, 2009; Beilock & Maloney, 2015; Grootenboer & Hemmings, 2007; Jacob et al., 2017; McKinney et al., 2009; Pajares & Miller, 1997; Xie et al., 2023).

Regarding mindset beliefs, most early mindset research was conducted under the assumption that mindset beliefs are domain-general–referring to the belief that abilities and intelligence can be improved with efforts and consistency across all domains or contexts (Dweck & Leggett, 1998). However, various scholars argue that all individuals do not hold the same beliefs (fixed vs. growth) about intelligence across all areas/contexts; rather, mindset beliefs can differ significantly depending on different domains (Dweck & Yeager, 2019; Cutumisu & Lou, 2020; Lewis et al., 2021; Maibach & Murphy, 1995; Yeager et al., 2019). For instance, it is not uncommon for a person to adopt a growth mindset in one area, such as reading, while maintaining a fixed mindset in another, such as mathematics (Cutumisu & Lou, 2023; Furnham, 2014). Further, research shows that beliefs about the malleability of intelligence follow different developmental trajectories across different academic subjects (Gunderson et al., 2017). For example, Scott and Ghinea (2013) reported that a programing-specific mindset was a stronger predictor of undergraduate students' engagement in programing practice than a general intelligence mindset which was delivered through instructional content.

Further recent studies have emphasized that individuals' perceptions of their ability can be highly context-dependent, giving rise to what are now referred to as domain-specific mindset beliefs (Dweck, 2024; Chen & Pajares, 2010; Gunderson et al., 2018; Korstange et al., 2020; Luarell et al., 2025; O'Keefe et al., 2021; Takehashi et al., 2024). Additionally, evidence on the effectiveness of growth mindset interventions in improving motivation and academic outcomes of the students remains mixed. For example, recent meta-analyses and large-scale studies reveal that the effects of general growth mindset interventions tend to be medium to low and inconsistent (Burnette et al., 2023; Dweck et al., 2014; Macnamara & Burgoyne, 2023; Mills & Mills, 2018), raising important questions about their generalizability and impact within mathematics contexts. This emerging shift about domain specificity in literature reflects a deeper understanding of mindset scale development, one that moves beyond a generalized view of intelligence to recognize the domain-dependent ways individuals think about their abilities within specific contexts. Therefore, keeping in mind the conception of domain-specific mindset beliefs, the present study focused on university students from the mathematics department and focused on their mathematics related growth mindset beliefs and self-efficacy.

Additionally, a body of literature focusing on mathematics-specific academic research has expanded in recent years, aiming to better understand the psychological and motivational factors that influence students' mathematics achievement motivation and engagement (Ashcraft & Moore, 2009; Blackwell et al., 2007; Pajares & Miller, 1994; Martinez et al., 2022; Ramirez et al., 2018; Schoenfeld, 2016). Mathematics is recognized as a foundational prerequisite for success in overall STEM disciplines (Boaler, 2016) and students' early perceptions of their mathematics abilities often influence their decision to pursue a degree in either STEM or non-STEM fields (Dweck, 2006; Wigfield & Eccles, 2002; Yeager & Dweck, 2012). Most students develop negative perceptions or attitudes toward their mathematical abilities, due to various factors such as personal mindset beliefs, self-efficacy, teacher related factors (i.e., mindset beliefs, teaching practices etc.), parental expectations, and culturally embedded gender biases (Bandura, 1997; Beilock & Maloney, 2015; Grootenboer & Hemmings, 2007; Jacob et al., 1991;

Jacob et al., 22009; McKinneyet al., 2009). Considering this conception of domain-specific mindset beliefs, the present study investigates the impact of effective instructors' feedback perceptions on students' mathematics growth mindset beliefs and self-efficacy, and how these in turn influence students' achievement goal orientations.

Problem Statement

Although teachers often report providing extensive feedback, research indicates that its effectiveness of feedback depends less on how much feedback provided and more on how students perceive and interpret it (Harks et al., 2013; Rakoczy et al., 2013; Strijbos et al., 2010). Students' perceptions of teachers' feedback are shaped by situational and individual factors that influence their beliefs about intelligence, self-efficacy, and achievement motivation (Havnes et al., 2012; Jiang et al., 2017; Schunk, 2012). Evidence also suggests that many students develop negative attitudes toward mathematics and exhibit low self-efficacy which may negatively affect their motivation and achievement related outcomes (Beilock & Maloney, 2015; Jacob et al., 2007; McKinney et al., 2009).

Furthermore, considering domain specificity about mindset beliefs plays a critical role in how students interpret and benefit from feedback (Scott & Ghinea, 2013). Given the importance of mathematics achievement, the role of effective feedback in learning, and students' self-belief about their mathematical abilities, it is important to understand the mechanisms through which these factors interact. Importantly, this study does not evaluate teachers' feedback practices as characteristically "effective" or "ineffective" not does it make judgments about teacher quality. Rather, the current study focuses on students' reports of how frequently instructors demonstrate feedback behaviors that are theoretically and empirically recognized as characteristics of effective feedback (Hattie & Timperley, 2007). Understanding these perceptions is important because students may perceive and respond to the same feedback practices differently depending on their prior experiences, beliefs, and motivational characteristics.

While ineffective feedback is also important, this study focuses specifically on students' perceptions about their instructor's effective feedback because growth mindset beliefs and self-efficacy are most strongly influenced by feedback that students perceive as clear, actionable, and motivating (Hattie & Timpereley, 2007). Although prior studies have examined feedback, mindset beliefs, self-efficacy, and achievement motivation separately, limited research has investigated how students' perceptions of instructor's feedback practices related to achievement goals through growth mindset and self-efficacy. More specifically, no study to date has investigated the mediating role of math growth mindset and self-efficacy in the relationship between students' perceptions of effective instructor feedback and their achievement goals, particularly among mathematics undergraduates.

Purpose of the Current Study

The purpose of the current study is to investigate whether undergraduate mathematics students' perceptions of their instructors' feedback practices influence their achievement motivation through the mediating roles of mathematics growth mindset and self-efficacy. Specifically, the study examines how students' perceptions of instructors' feedback practices that are theoretically associated with effective feedback may relate to students' beliefs about their mathematical abilities, their confidence in performing mathematical tasks, and their achievement goals orientations. This study is significant because it explains the mechanisms through which students' perceptions of instructors' effective feedback are associated with their motivational beliefs and achievement motivation within mathematics context. By focusing on students' perceptions rather than judgments of teachers' feedback effectiveness, the study contributes to understanding how feedback practices consistent with effective feedback may differentially influence students' mathematics growth mindset, self-efficacy, and achievement goal orientations.

Research Questions

Q1: Is perception of effective feedback related to mindset beliefs, self-efficacy, and achievement goal orientations in math classes?

Q2: Do growth mindset and self-efficacy mediate the relationship between students' perceptions of instructors' effective feedback practices and their achievement goal orientations?

Chapter 2: Theoretical Background and Review of Literature

Understanding the factors that influence students' achievement motivation in mathematics requires a comprehensive examination of both the instructional practices they experienced and the psychological processes (e.g., mindset beliefs and self-efficacy) that mediate their learning. In recent years, research has increasingly highlighted the role of these psychological and motivational factors in shaping students' mathematics achievement motivation (Ashcraft & Moore, 2009; Blackwell et al., 2007; Pajares & Miller, 1994; Ramirez et al., 2019; Schoenfeld, 2016). The focus of the current study is to examine the role of effective instructor's demonstration of behaviors consistent with effective feedback in predicting mathematics students' achievement goal orientations. However, this influence is not direct; rather, it operates through intervening factors (math growth mindset and self-efficacy). The purpose of this study is to examine and explain this process, exploring how students' perceptions of instructors' feedback behaviors impact math students' growth mindset beliefs about their math ability, self-efficacy and consequently, their achievement goals orientation in mathematics.

This chapter reviews the theoretical perspectives and empirical research that ground the present study, focusing on five major frameworks: the student-Feedback Interaction Model (Lesnevich & Smith, 2022), the Feedback Model (Hattie & Timperley, 2007), Growth Mindset Theory (Dweck, 2006; Dweck & Leggett, 1989), Self-Efficacy Theory (Bandura, 1997), and Achievement Goal Theory (Elliot & McGregor, 2001). Collectively, these perspectives provide a comprehensive foundation for examining how students' perceptions of instructors' feedback influence their mathematics-related growth mindset and self-efficacy, which in turn affect their achievement goal orientations in mathematics.

The structure of this chapter begins with a discussion of the five theoretical perspectives that provide the foundation for the present study and guide the development of its process model. Next the chapter defines the key study constructs perceived perceptions of instructor feedback practices, growth mindset, self-efficacy, and achievement goals. Building on these definitions, I have provided theoretical arguments and reviewed relevant empirical literature to explain how perceived feedback influences mathematics students' achievement goals indirectly through their math growth mindset and self-efficacy.

Theoretical Perspectives

Student-Feedback Interaction Model (Lipnevich & Smith, 2022) and Feedback Framework (Hattie & Timperley, 2007). Students' perceptions of feedback and its effects on academic outcomes and motivation are well explained in Lipnevich and Smith's (2022) revised student feedback interaction model. This model suggests that the effectiveness of feedback depends not only on the message delivered but also on the ways students perceive, make sense of, and act upon it. Importantly, this model emphasizes that the impact of feedback is shaped by multiple layers, including the context or situation, the characteristics of both the feedback giver and the student's personal characteristics as recipient of feedback. Effective feedback perception increases motivation, persistence, and learning while ineffective feedback perception leads to feelings of incompetence, frustration, and discouragement which further leads to maladaptive behaviors.

For defining and categorizing effective and ineffective feedback, current study focuses on feedback theory by Hattie and Timperley (2007). Effective Feedback is characterized as formative, timely, specific, growth-oriented, and actionable information provided to students, designed to modify their cognitive or behavioral processes in ways that improve learning (Hattie

& Timperley, 2007; Shute, 2008). Ineffective Feedback refers to--normative, vague, delayed, overly general, negative, judgmental, grade focused, insensitive, or disconnected from learning goals, all of which reduce its usefulness for student growth (Brookhart, 2008; Hattie & Timperley, 2007; Shute, 2008).

A central contribution of the model is its recognition that students' perceptions of feedback involve cognitive, affective, and behavioral processes, which together determine how feedback influences learning outcomes. For example, He et al. (2023) investigated how feedback perceptions influence students' learning motivation and found that perceived effective feedback was a strong predictor of self-regulated learning through self-efficacy and achievement goal orientations. Similarly, Al-Darei and Elhang (2022) revealed that effective feedback significantly and positively predicted eighth-grade students' learning motivation by examining the impact of different types of feedback on students' motivation.

Further, Zedan (2021) reported that elementary mathematics students perceived teacher feedback, particularly motivational feedback, as the strongest predictor of their achievement motivation. More recently, Muthukrishnan et al. (2024) investigated the role of growth mindset beliefs in the relationship between students' perceptions of English language teachers' feedback and their learning performance, finding that process-oriented feedback (i.e., effective feedback) was a positive and significant predictor of growth mindset beliefs, which in turn enhanced students' language learning performance.

Considering all the evidence and by placing students' perceptions of instructors' feedback practices that are consistent with effective feedback as the focus the model shifts the emphasis away from feedback as a static instructional tool and toward feedback as a dynamic interaction between teacher and students. This perspective directly aligns with the current study's goal of examining how students' interpretations /perceptions of instructors' effective feedback approach shape their growth mindset, self-efficacy, and achievement motivation, particularly in mathematics learning contexts.

***Growth Mindset Theory (Dweck, 2006; Dweck & Leggett, 1989)* --** According to Carol Dwecks' Mindset beliefs theory, people generally hold either a fixed mindset (the belief that intelligence and abilities are innate and unchangeable) or a growth mindset (the belief that abilities can be developed through effort, effective strategies, and learning from feedback). These contrasting beliefs influence how students approach challenges, respond to failure, and engage with learning opportunities. Individuals with growth mindset beliefs are more likely to accept challenging tasks and continue to improve over time, while those having fixed ability beliefs tend to avoid challenges or often fail to actualize their potential (Dweck & Yeager, 2019).

Growth mindset beliefs promote viewing challenges as opportunities for growth, embracing effort as a pathway to learning, and demonstrating resilience in the face of setbacks (Dweck, 1999; Dweck & Yeager, 2019; Yeager & Dweck, 2012). In contrast, those with fixed mindset beliefs are more likely to avoid challenges, give up quickly when faced with difficulty, and interpret failure as evidence of limited ability (Dweck & Yeager, 2019; Yeager & Dweck, 2012). Empirical evidence further supports these theoretical claims: growth mindset has been identified as a predictor of both achievement motivation and academic performance (Claro et al., 2016; Dweck, 2009; Yeager et al., 2019). Students with a growth mindset are often higher achievers, partly because it is associated with positive psychological characteristics such as self-efficacy and confidence (Zhao et al., 2020). Other studies demonstrate that growth mindset positively predicts self-efficacy, motivation, performance, and learning engagement (Bai & Wang, 2023; Lin-Siegler et al., 2016) and is consistently associated with higher academic achievement and engagement across contexts (Kim & Park, 2021; Sheffler & Cheung, 2024). In mathematics specifically, research shows that students with growth mindset beliefs achieve at higher levels compared to peers with fixed beliefs (Blackwell et al., 2007; Romero et al., 2014).

Considering these empirical findings within the context of the current study, Growth Mindset Theory provides a useful lens for understanding the role of mindset beliefs in the hypothesized model.

***Self-Efficacy Theory (Bandura, 1986)* --** Self-efficacy is a core component of Bandura's social cognitive theory and an important motivational construct. Bandura defines self-efficacy as a self-assessment about one's ability to perform the set of actions that are necessary to achieve a designated level of performance in different contexts (Bandura, 1986, 2003). This ability related to self-beliefs shape individuals' goals, their levels of motivation and engagement when performing tasks, and their self-reactions in the case of challenge or failure (Hardre et al., 2007; Schunk, 2003).

Bandura identifies four main sources which can affect self-efficacy (e.g., mastery experiences–successful experience leads to high self-efficacy, vicarious experiences–observing others success can enhance self-efficacy, verbal persuasion, constructive feedback or encouragement leads to high self-efficacy, and physiological and effective stage-positive emotions increase while negative emotions decrease the level of self-efficacy). Self-efficacy has been found to be a strong predictor of student's achievement motivation as this reflects students' beliefs about their competence with respect to the academic tasks (Schunk & Pajares, 2002).

Extensive research has demonstrated that self-efficacy is a strong predictor of students' achievement motivation, reflecting their beliefs about competence in relation to academic tasks (Schunk & Pajares, 2002). Importantly, self-efficacy has also been shown to be shaped by the type of feedback students receive from instructors. For example, Chan and Lam (2010) found that seventh- and eighth-grade students who received summative feedback reported lower self-efficacy compared to those who received normative or self-referenced (i.e., more effective) feedback. Similarly, other studies highlight the positive relationship between effective feedback and self-efficacy in supporting academic learning (Brown et al., 2016; Paunesku et al., 2015; Zimmerman, 2000). In addition, self-efficacy has been shown to be closely linked to achievement motivation. For instance, Mohsenpour et al. (2008) reported that self-efficacy was positively associated with mastery goal orientation, which in turn predicted mathematics achievement. Similarly, Harde et al. (2007) also noted that high self-efficacy of students leads to mastery and performance approach goals adoption and improve students' level of competence.

Therefore, the current study is based on this theoretical perspective, which emphasizes the central role of self-efficacy in learning and motivation and is supported by empirical evidence. It closely aligns with the study's aim by highlighting how students' perceptions of effective feedback can shape their self-efficacy beliefs, thereby influencing their achievement motivation.

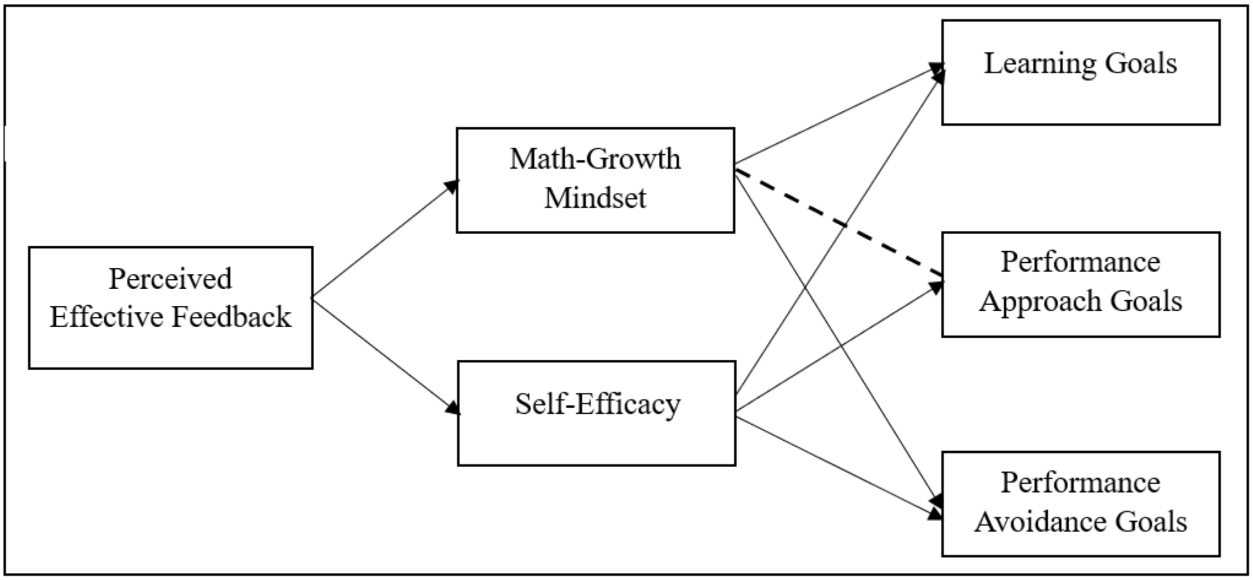
Achievement Goal Theory (Elliot & McGregor, 2001) **--**The ultimate outcome of the current study is students' achievement goal orientation, which is grounded in achievement goals theory. Motivation has been identified as a critical academic construct that influences students' learning, persistence, and engagement (Deci & Ryan, 2002; Wentzel & Miele, 2016). Achievement Goal Theory provides a framework for understanding the motivational patterns underlying the goals students set for themselves. According to this theory, achievement goals are conceptualized as "the purposes or reasons for engaging in a task, as they establish the perceptual set for how individuals interpret and experience achievement settings" (Elliot et al., 1999, p. 549). These goals shape students' cognitive, effective, and behavioral responses to challenges and failure (Elliot & Dweck, 1983). Specifically, mastery goals focus on developing competence and gaining mastery; performance-approach goals emphasize demonstrating competence relative to others; and performance-avoidance goals involve avoiding failure or appearing incompetent (Elliot & Dweck, 1983; Nicholls, 1989).

Recent empirical research highlights the critical role of achievement goals in students' learning and motivation. For example, mastery goals have been found to be negatively associated, and performance-avoidance goals positively associated, with motivation instability and lack of persistence (Umemoto & Inagaki, 2023). Similarly, mastery goals predict active coping strategies, persistence, motivation, and higher achievement in the face of challenges compared to performance-approach goals (Grant & Dweck, 2003). Mastery goals are also positively linked to intrinsic motivation, whereas performance-avoidance goals are negatively associated with intrinsic motivation (Church et al., 2001; Elliot & Murayama, 2008). Additionally, mastery goals have been consistently related to deeper cognitive engagement, greater effort expenditure, and sustained persistence across multiple studies (DeBacker & Crowson, 2006; Elliot & McGregor, 2001; Senko et al., 2011).

Prior research has also highlighted the influence of feedback types on achievement goal orientation (Pekrun et al., 2014; Keller et al., 2024). Given the significance of achievement goals in shaping students' motivation, persistence, cognitive engagement, coping strategies, and learning outcomes, the present study follows Achievement Goal Theory to examine how different types of goals are influenced by math students' perceptions of instructors' effective feedback through math growth mindset beliefs and self-efficacy.

Theoretical Model

Figure 1. Model for students' perceptions about their instructors' feedback predicting students' personal factors (self-efficacy and growth mindset) and their achievement goals orientations.



Note. Solid path lines represent directional predictions. Dotted path lines represent hypotheses which assume either positive or negative correlation between growth mindset and performance approach goals.

Perceived Effective Feedback and Growth Mindset Beliefs of Math students

Feedback is considered a critical component of learning and motivation (Hattie & Timperley, 2007; Koenka et al., 2021; Ferris, 2013). The types of feedback teachers provide are influenced by their own personal self-beliefs about their abilities, which in turn shape students' motivation and achievement (Dweck, 2006; Hwang, 2025; Kraker-Pauw et al., 2017; Robinson & Bond, 2025). In general, feedback refers to any form of information (oral or written) provided by teachers to students about their classroom performance, behaviors, or understanding, with the aim of enhancing learning (Smith et al., 2015).

Hattie and Timperley (2007) define feedback as "information provided by an agent (e.g., teacher, peer, book, parent, self, experience) regarding aspects of one's performance or understanding" (p. 81). Within this conceptualization, the primary purpose of feedback is to highlight the discrepancy between a learner's current performance/understanding and the intended learning goals, and to support the learner in reducing that discrepancy (Hattie and Timperley (2007). Effectiveness of feedback on students' achievement motivation depends on the characteristics of the feedback (Hattie & Timperley, 2007; Shute, 2008; Wisniewski et al, 2020). Feedback has also been further categorized into effective and ineffective forms, depending on the characteristics of the feedback itself, the provider, and the context in which it is delivered (Hattie & Timperley, 2007; Shute, 2008; Smith et al., 2020).

Effective Feedback refers to formative, timely, specific, growth-oriented, and actionable information provided to students, designed to modify their cognitive or behavioral processes in ways that improve learning (Hattie & Timperley, 2007; Shute, 2008).

Ineffective Feedback refers to feedback that is normative, vague, delayed, overly general, negative, judgmental, grade focused, insensitive, or disconnected from learning goals, all of which reduce its usefulness for student growth (Brookhart, 2008; Hattie & Timperley, 2007; Shute, 2008).

Empirical evidence shows that effective feedback, often paired with encouragement, is positively associated with students' growth mindset and motivation, while ineffective feedback tends to reinforce fixed mindset beliefs (Bragg et al., 2016; Muller & Dweck, 1998; Kamins & Dweck, 1999; Truax, 2018). Well-structured feedback that students actively engage with fosters intrinsic motivation, reduces reliance on extrinsic motivators, and promotes achievement (Koenka et al., 2021; Price et al., 2010; Price et al., 2013; Zedan, 2021). In contrast, vague, overly critical, or performance-oriented feedback undermines motivation, engagement, and performance (Ekholm et al., 2015; Fong et al., 2019; Hattie & Timperley, 2007; Winstone et al., 2017). For example, Kamins and Dweck (1999) reported that performance-based feedback led students to interpret mistakes as evidence of personal failure, while feedback attributed to intelligence was found to affect task involvement, persistence, and self-efficacy (Gunderson et al., 2018; Schunk, 1996). Similarly, feedback that emphasizes results over learning processes has been shown to reduce motivation and engagement (Kraker-Pauw et al., 2017; Shute, 2008).

Earlier research largely prioritized identifying strategies for delivering feedback effectively to enhance learning and motivation (e.g., Hattie & Timperley, 2007). Although on average feedback was found to have positive impact, studies highlighted that not all types of feedback are equally effective (for review see Hattie & Timperley, 2007; Kluger & DeNisi, 1996). More recently, however, argues that the effectiveness of feedback depends less on delivery and more on how learners process and respond to it (Lipnevich & Smith, 2022; Mandouit & Hattie, 2023).

Perceptions of feedback practices reflect students' experiences of how frequently instructors engage in instructional practices associated with effective feedback, such as providing process-oriented comments, offering opportunities for revision, and giving actionable guidance for improvement. These perceptions are critical because they determine whether feedback is experienced as supportive and growth-promoting or as discouraging and performance-oriented. Moreover, research suggests that discrepancies often exist between teachers' intended feedback practices and students' actual perceptions of those practices (Kroeper et al., 2022), reinforcing the importance of examining feedback from the learner's perspective.

This shift underscores the importance of students' perceptions of effective feedback when feedback is perceived as clear, supportive, learning-oriented, and actionable, it is more likely to encourage engagement and growth. In contrast, when perceived as discouraging, vague, insensitive, or performance-based, it is more likely to undermine motivation and reinforce fixed beliefs. Importantly, teachers' self-reported feedback practices often differ from how students experience and perceive them (Kroeper et al., 2022). Thus, it is students' interpretations not teachers' intentions that ultimately determine whether feedback functions as a catalyst for growth or a barrier that sustains fixed mindsets, a question that remains unsettled in mindset research. Addressing this gap, the present study examines how students' perceptions of instructors' effective feedback practices influence their mathematics mindset beliefs. Because feedback effectiveness is also context-dependent (Lipnevich & Smith, 2022), this study focuses on mathematics, a domain in which students frequently hold negative ability beliefs that may be reinforced by ineffective feedback. Previous research on feedback and math mindset beliefs has found inconsistent findings (Van der Kleij et al., 2019; Shute, 2008), possibly because growth mindset is often treated as domain general rather than domain specific construct. By using a mathematics-specific measure of growth mindset this study aims to provide a clearer picture considering math context and math-specific mindset scale of measurement. The proposed model hypothesizes that students' perceptions of teachers' feedback practices consistent with effective feedback would positively predict math growth mindset among undergraduate mathematics students.

Perceived Feedback and Self-efficacy

Self-efficacy is a core component of Bandura's social cognitive theory (1986) and an essential motivational construct in education. According to Bandura, self-efficacy refers to an individual’s belief in their capacity to organize and carry out the actions necessary to attain specific performance levels in particular contexts. These self-beliefs strongly influence individuals’ goals, their motivation and engagement when performing tasks, and their reactions to challenges or failures (Hardre et al., 2007; Schunk, 2003).

A substantial body of research demonstrates that effective feedback is positively associated with higher levels of students’ self-efficacy (Harks et al., 2014; Pajares & Johnson, 1996; Schunk & Rice, 1991; Zimmerman & Kitsantas, 2002). In particular, elaborative and informative feedback focused on strategies, processes, and progress has been found to have a stronger positive effect on students’ motivation and self-efficacy compared to performance- or outcome-based feedback (Capa-Aydin et al., 2009; Finn et al., 2018; Kulhavy et al., 1989; Narciss, 2004).

Moreover, research also indicates that students’ level of self-efficacy is closely tied to how they engage with and perceive feedback. For instance, students with higher self-efficacy are more likely to interpret feedback constructively, respond with persistence, and utilize it to enhance their learning (Adams et al., 2020; Baate & Schnotz, 2014; Gan et al., 2023). Thus, perceived feedback and self-efficacy operate in a reciprocal relationship: effective feedback strengthens self-efficacy, while higher self-efficacy fosters deeper engagement with feedback.

Similarly, instructors’ feedback has been found to enhance students' self-efficacy in reading and writing, while also reducing writing anxiety (Bilbro et al., 2013; Hill & Edwards, 2019; Mauri et al., 2016; Rukszu, 2014). Ruegg (2014) investigated the effects of teacher and peer feedback on second-language learners’ writing self-efficacy and found that teacher feedback was significantly and positively associated with writing self-efficacy to a greater extent than peer feedback. In contrast, Yin et al. (2008) explored the impact of perceived usefulness of effective/formative feedback on middle school students' self-efficacy and motivation but reported no significant effect of feedback on self-efficacy. They argued that this non-significant result was due to the poor implementation of feedback by instructors (Furtak et al., 2008). Similarly, Liu and Gumah (2020) highlighted that the effectiveness of feedback on students' self-efficacy depends largely on the perceived value of the feedback. Supporting this perspective, Chan and Lam (2010) examined the impact of effective versus ineffective feedback on English vocabulary acquisition-related self-efficacy among eighth-grade Chinese students and found that formative feedback had a significantly more positive impact on students' self-efficacy compared to summative/ineffective feedback.

In the mathematics context, students often report lower levels of self-efficacy (Tait-McCutcheon, 2008; Tanner & Jones, 2003). Self-efficacy, however, has consistently been shown to be positively associated with students' mathematical performance (Pajares & Graham, 1999). Empirical evidence highlights that process-oriented and strategy-based feedback (as a form of effective feedback) enhances students' math self-efficacy, whereas outcome-based praise or discouragement-related feedback diminishes their self-efficacy in mathematics (Burnett, 2003; Harks et al., 2014; Schunk, 1982). Kyaruzi et al., (2019) examined the relationship between self-efficacy, teachers' formative feedback, and mathematics performance among secondary school students, revealing that formative feedback not only strengthened students' self-efficacy but also improved their mathematics performance.

Similarly, Smith et al. (2023) explored the role of formative feedback in supporting primary students' mathematical reasoning practices, with self-efficacy as a mediating factor. Their findings indicated that formative feedback significantly predicted students' self-efficacy, though it did not directly influence mathematical reasoning. Furthermore, Fast et al. (2010)

found that elementary students who perceived their mathematics classrooms as supportive and mastery-oriented, designed by teachers' instructional practices and feedback, reported higher levels of self-efficacy in mathematics.

Considering these theoretical and empirical findings, it is evident that although substantial research has established a link between feedback and self-efficacy across various domains, relatively few studies have explicitly examined this relationship within the mathematics context, particularly from the perspectives of students' perceptions of instructors' effective feedback practices. The limited but growing body of research suggests that effective feedback– i.e., process-oriented and formative feedback– has the potential to foster mathematical self-efficacy, whereas ineffective or discouraging feedback can undermine it. However, inconsistencies in findings such as those reported by Yin et al. (2008) indicate that the effectiveness of feedback is not universal but depend on factors such as implementation quality and students' interpretations of feedback. This gap in literature highlights the need for further exploration of how students' perceptions of instructors' demonstration of feedback practices consistent with effective feedback shape their self-efficacy in mathematics. Building on these insights, the present study hypothesizes that perceptions of instructors' effective feedback practices positively predict students' self-efficacy regarding mathematics.

Math Growth Mindset and Achievement Goals Orientation

Achievement goals refer to the purposes or reasons for engaging in a task, as they establish the perceptual set for how individuals interpret and experience achievement settings" (Elliott et al., 1999, p. 549). Achievement goals influence students' cognitive, effectiveness, and behavioral responses to challenges and failure (Elliott & Dweck, 1983).

Mastery Goals–Mastery (or learning) goals are those adopted with the purpose of developing competence and gaining mastery during learning (Elliott & Dweck, 1988). Students with mastery goals are more self-regulated, focusing on skill development and problem-solving as part of their learning process (Miller & Greene, 1999; Harlow et al., 2011). Because mastery goals are self-referential, students pursue learning for its own sake, valuing progress and understanding rather than seeking to demonstrate competence to others (Nicholls, 1989).

Performance Approach Goals–Performance goals are oriented toward demonstrating competence relative to others rather than focusing on personal growth (DeBacker & Crowson, 2006). Within this framework, performance-approach goals involve striving to show one's abilities and gain favorable judgments from others (DeBacker & Crowson, 2006). While these goals may motivate students to engage in learning tasks, the emphasis is on proving competence rather than developing it, showing sensitivity to failures, and avoiding challenges (Elliott & Dweck, 1988; Elliot & McGregor, 2001; Nicholls, 1989).

Performance Avoidance Goals– Performance-avoidance goals involve avoiding failure or appearing incompetent (Elliott & Dweck, 1988; Elliot & McGregor, 2001; Peixoto et al., 2025). Students holding performance avoidance goals perceive the learning situation as threatening (Harlow et al., 2011).

Students' beliefs about intelligence, whether viewed as fixed or malleable, play a crucial role in shaping their academic achievement goals (Dweck & Leggett, 1988). These beliefs influence students' motivation, effort, and persistence, and in turn, affect their long-term academic success (Dweck, 2006). Prior research has consistently reported a positive association between a growth mindset and mastery-oriented goals, while a fixed mindset has been linked with performance-oriented goals. For instance, Blackwell et al. (2007) investigated the role of mindset beliefs about intelligence in mathematics achievement among seventh-grade students. Findings from two longitudinal studies revealed that incremental beliefs about intelligence were positively associated with mastery goal orientation, whereas entity beliefs were linked with performance-approach goals among math students.

Dweck and Leggett (1988) framework also provided a theoretical explanation about helpless versus mastery-oriented patterns of cognition, affect, and behaviors. They argued individuals' mindsets are associated with the achievement goals they adopt during learning tasks. According to their model, students with mastery goals view challenging tasks as opportunities to grow their competence, motivating them to embrace challenges despite potential failure. They demonstrate solution-focused problem-solving, self-monitoring, and task-focus. In contrast, students with performance goals prioritize proving their abilities or avoiding failure, which often leads to avoiding challenges and experiencing negative emotions when receiving negative feedback (Dweck & Leggett, 1988).

Traditionally, growth mindset has been associated positively with mastery goals and fixed mindset with performance goals (Blackwell et al., 2007; Dweck & Elliot, 1983), but some studies (e.g., Dickhauser et al., 2016; Molden & Dweck, 2000; Yu & McLellan, 2020), reported that students with growth mindset beliefs can pursue performance goals along with mastery goals because even with growth mindset beliefs they sometime seek for validation about outperforming their peers instead of only concentrating on learning and personal development.

Additionally, some meta-analyses (Burnette et al., 2013; Burnette et al., 2020; Sisk et al., 2018) have reported similar relationship between students' mindset beliefs and their achievement goals orientation by highlighting that people may have association between their mindset and achievement goals in different ways than what is expected from current theoretical perspectives as they found the relationship between growth mindset beliefs and both types of goals (i.e., mastery and performance). Further, some other studies (Chen & Wong, 2015; Schwinger et al., 2016) suggested some mixed findings by indicating that students with growth mindset beliefs might have moderate-low mastery goals orientation and moderate-low correlation with performance goal orientation also instead of high-performance goals orientation which further complicated this relationship.

Considering the inconsistent findings regarding growth mindset beliefs and achievement goal orientations, as well as the clear gap in the literature on mathematics undergraduate students, it is crucial to examine how math-specific growth mindset influences students' achievement goal orientations. These inconsistencies may partly stem from treating growth mindset as a domain-general construct in most prior studies. Accordingly, I hypothesize that math growth mindset would positively be associated with mastery goals and negatively associated with performance avoidance goals. Additionally, math growth mindset hypothesized to have either positive or negative association with performance approach goals

Students' Self-efficacy and Achievement Goals Orientation

Self-efficacy refers to self-assessment about one's ability to perform the set of actions that are necessary to achieve a designated level of performance in different contexts (Bandura, 1986, 2003). This ability related to self-beliefs shapes individuals' goals, their levels of motivation and engagement when performing tasks, and their self-reactions in the case of challenge or failure (Hardre et al., 2009; Schunk, 2003). Multiple studies have documented the positive correlation between self-efficacy and learning goals (Alhadabi & Karpinski, 2020; Dickhauser et al., 2016; Palos et al., 2020; Walker & Greene, 2009). Dweck and Leggett's (1988) framework also suggests that students' self-concepts about their abilities influence achievement goals through their impact on self-esteem during learning. Those with a growth mindset gain self-esteem from mastering challenges and are more likely to adopt mastery goals, while those with a fixed mindset derive self-esteem from success, leading them to adopt performance goals.

Situational factors might also influence the relationship between self-efficacy and achievement goal orientations. For example, Hulleman et al. (2010) reported that individuals high in self-efficacy are less likely to adopt performance avoidance goals since they believe they have the capability to meet the performance standard. In support of this, previous studies have demonstrated that self-efficacy is positively correlated with mastery and performance-approach goals and negatively to non-significantly correlated with performance-avoidance goals (Elliot, 1999; Hardre et al., 2007; Huang, 2011; Pajares & Cheong, 2003; Palos et al., 2024). Similarly, Hackett et al. (1995) argued that higher self-efficacy is associated with performance accomplishment/performance approach goals of students.

While there is substantial evidence supporting the predictive role of self-efficacy on achievement goals, several gaps remain. First, prior studies have yielded inconsistent findings regarding the specific link between mathematics self-efficacy and mastery goals, suggesting the need for further examination in discipline-specific contexts. Second, most of the research has examined self-efficacy and achievement goals broadly across academic subjects, with limited focus on undergraduate mathematics students, a group that often faces unique challenges related to mindset, mathematics self-efficacy, and performance (Pajares et al., 1999). Third, relatively few studies have tested these relationships simultaneously with performance-approach, mastery, and performance-avoidance goals in mathematics, leaving unclear whether the established patterns in general academic domains hold in mathematics specifically.

Therefore, based on theoretical perspectives and discrepancies in the empirical evidence, I hypothesize that self-efficacy positively predicts both mastery and performance-approach goals, while negatively predicting performance-avoidance goals among mathematics students. This assumption is grounded in the notion that self-efficacy in mathematics represents one's belief in one's capability to utilize the personal and cognitive resources necessary to attain a given level of performance. Depending on whether the performance standard is self-referential (improvement relative to prior competence) or socially comparative (demonstrating competence to others), higher self-efficacy may foster either mastery or performance-approach goals. Conversely, students with strong mathematics self-efficacy are less likely to adopt performance-avoidance goals, since avoidance is typically associated with low confidence and fear of failure.

Mediating Role of Math Growth Mindset and Self-efficacy

Empirical evidence as mentioned in above paths descriptions of this chapter suggests that teacher-related factors, particularly perceived feedback, are closely associated with students' mindset beliefs and self-efficacy in mathematics (Rattan et al., 2012). Students' beliefs about their abilities function as important psychological factors that influence the kinds of achievement goals they adopt (Burnette et al., 2013; Schunk & DiBenedetto, 2016). Building on this, the present study argues that the influence of perceived instructor feedback on students' achievement motivation is more effectively explained through its impact on mindset beliefs and self-efficacy rather than through direct effects of feedback alone. A study by Ahmed et al. (2021) found a significant mediating role of self-efficacy between the teachers' constructive and evaluative feedback and their academic performance.

Existing research consistently highlights that growth mindset beliefs and self-efficacy are stronger and more proximal predictors of achievement-related behaviors and outcomes than external instructional factors (Dweck & Leggett, 1988; Bandura, 1997; Schunk, 2003). For instance, students who perceive feedback as process-oriented and strategy-focused are more likely to endorse a math growth mindset and to report higher levels of self-efficacy (Mueller & Dweck, 1998; Harks et al., 2014). These beliefs subsequently predict the adoption of mastery goals and, in many cases, performance-approach goals, while lowering tendencies toward performance-avoidance goals (Hulleman et al., 2010; Huang, 2011).

Despite this evidence, relatively few studies have explicitly examined how students' perceptions of their instructors' effective feedback influence achievement motivation through the mechanisms of math growth mindset and self-efficacy. Most existing studies treated feedback as an antecedent to academic outcomes, but relatively few investigate the underlying belief systems that may explain this link. This presents a significant gap, particularly within the mathematics context at the undergraduate level, where feedback is both frequent and central to students' academic experiences.

Accordingly, the present study proposes that students who perceive their instructors' feedback as effective might be more likely to develop stronger math growth mindset beliefs and higher self-efficacy, which in turn might positively predict their adoption of mastery and performance-approach goals. By conceptualizing mindset and self-efficacy as mediators, this research extends prior models and offers a more nuanced explanation of how teacher-related factors shape students' achievement motivation in mathematics.

Significance of Current Study and Gaps in Literature

The purpose of this study is to examine the positive mechanism of how undergraduate mathematics students' perceptions of instructor effective feedback influence their achievement goals orientation through the mediating roles of math growth mindset and self-efficacy. By integrating the constructs of feedback, mindset beliefs, and self-efficacy into a single explanatory framework, this study proposes a pathway from perceived feedback to achievement goals, positioning mindset and self-efficacy as core mechanisms of achievement motivation (Bandura, 1997/2003; Dweck & Leggett, 1988; Schunk, 2003).

The literature on feedback has largely emphasized identifying what constitutes "effective" feedback and how it enhances learning outcomes. However, much less attention has been given to the perceptions students hold about feedback, which may differ significantly from instructors' intentions. A growing body of work suggests that students' perceptions about feedback are critical in determining whether it fosters motivation or reinforces fixed beliefs (Kroeper et al., 2022; Lipnevich & Smith, 2022). Feedback that is clear, actionable, timely, and oriented toward students' effort tends to strengthen motivation, self-efficacy, and learning outcomes, as several studies have shown (Van der Kleij et al., 2019; Lipnevich & Smith, 2022). While feedback that emphasizes effort and provides clear guidance can foster positive learning outcomes, students may perceive vague or performance-focused comments as discouraging, which can undermine motivation and learning (Kroeper et al., 2022).

Therefore, the current model solely focuses on the perceptions of effective feedback, keeping in mind that effective feedback positively predicts students' growth mindset beliefs and self-efficacy which in turn promote adaptive achievement goals orientations. To the best of my knowledge, no explicit study has explored how students' perceptions of effective feedback influence mindset beliefs, self-efficacy, and achievement goals in mathematics students (Kroeper et al., 2022; Lipnevich & Smith, 2022). This study addresses this gap by prioritizing math student perceptions rather than instructor practices.

Further, considering the importance of domain specificity in mindset development and the context dependence of feedback effectiveness, the role of perceptions of instructors' effective feedback in shaping student mindset beliefs and motivation within the mathematics domain remains underexplored. Prior research has documented a strong prevalence of fixed-ability beliefs and math-related anxiety in this domain (Pajares & Graham, 1999). Although formative feedback is often linked with gains in math self-efficacy and persistence, findings are inconsistent, particularly among students with fragile prior beliefs (Van der Kleij et al., 2019; Rattan et al., 2012). To address this gap, the present study focuses on first-year undergraduate mathematics students, a group whose beliefs are especially malleable yet vulnerable during the transition to higher education (Rattan et al., 2012; Yeager & Dweck, 2012). By centering on how perceptions of instructor's effective feedback practices influence students' growth mindset and self-efficacy, this study aimed to clarify the mediating processes through which effective feedback perception influences achievement-related outcomes such as goal orientation and cognitive engagement.

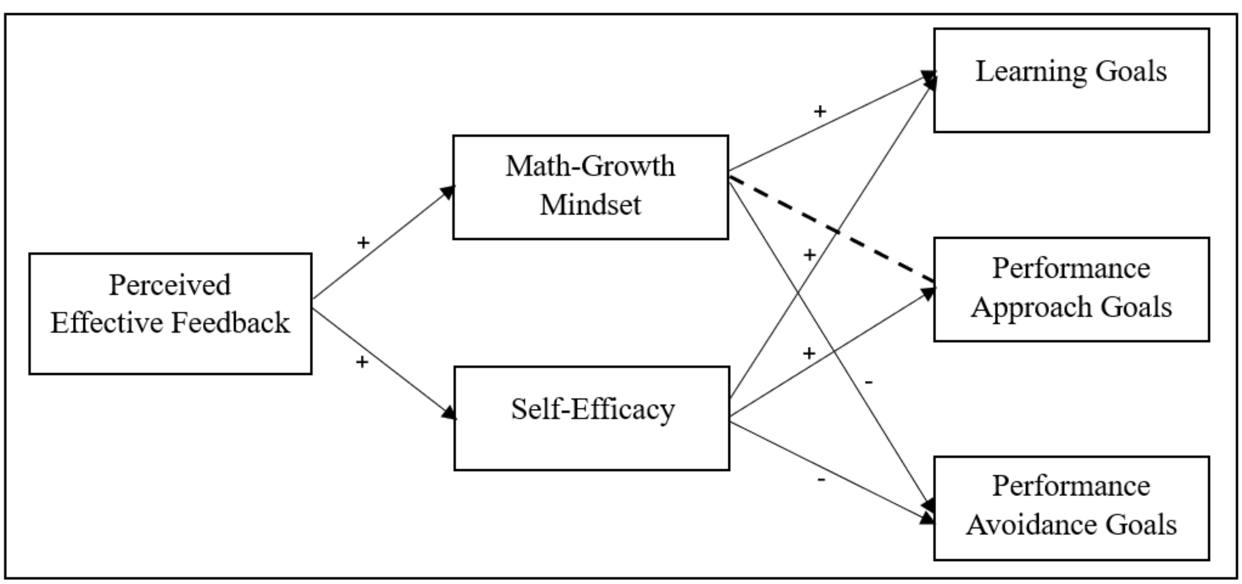
Apart from that, most prior research has tended to investigate feedback, mindset, and self-efficacy as separate variables, rather than examining how they may operate together. The current study contributes to existing literature by testing the mediating role of math growth mindset and math self-efficacy in explaining how perceived effective feedback influences students' achievement goal orientations. This mediational approach helps clarify why the same effective instructional feedback can influence learning outcomes differently across students depending on how they perceive and process the feedback.

Furthermore, it is also noted that most existing studies about feedback, growth mindset, self-efficacy, and achievement goals have focused on K-12, and adolescence as subject populations. Very few studies have focused on undergraduates, particularly from mathematics majors, despite the transitional challenges this group faces in adjusting to new expectations, competitive environments, and unfamiliar feedback systems. By focusing on freshmen mathematics students, this study contributes insight into a population that remains underrepresented in feedback, mindsets, and achievement motivation research.

Lastly, most prior studies have reported inconsistent results regarding the relationship between feedback perceptions, growth mindset and goal orientations (Butler, 2006; Burnette et al., 2013; Yu & McLellan, 2020), suggesting the need for a more comprehensive, belief-mediated model in the mathematics context. Based on all the empirical consistent and inconsistent findings and the gaps in existing literature, I have provided a hypothesis for the following model.

Hypothesized Model

Figure 2. Hypothesized Model for students' perceptions about their instructors' effective feedback predicting students' personal factors (self-efficacy and growth mindset) and their achievement goals orientations.



Note. Solid path lines represent directional predictions. Dotted path lines represent hypotheses which assume either positive or negative correlation between growth mindset and performance approach goals.

Hypotheses

- Perceptions of instructors' effective feedback practices positively predict math growth mindset beliefs and self-efficacy of mathematics undergraduates. This hypothesis is based on prior research suggesting that feedback emphasizing improvement, effort, strategies, and constructive guidance can strengthen students' beliefs that mathematical abilities are malleable and enhance their confidence in performing mathematics-related tasks (Hattie & Timperley, 2007; Schunk, 2003; Burnette et al., 2020). Because students' interpretations of feedback play a central role in determining motivational outcomes, students who perceive their instructors' feedback practices as supportive and improvement-oriented are expected to report stronger mathematics growth mindset beliefs and higher mathematics self-efficacy.
- It was hypothesized that mathematics growth mindset would positively predict mastery goals and negatively predict performance-avoidance goals among undergraduate mathematics students. However, the relationship between mathematics growth mindset and performance-approach goals was expected to be ambiguous and could be either positive or negative. This hypothesis is grounded in mindset theory along with inconsistent findings in existing literature, suggesting that students who believe mathematical ability can be developed through effort and learning are more likely to focus on improvement and mastery rather than solely on demonstrating ability (Dweck, 1999; Dweck & Leggett, 1988; Dweck & Yeager, 2019; Yeager & Dweck, 2012). At the

same time, prior research suggests that students with stronger growth mindset beliefs may also seek challenging tasks and opportunities to demonstrate competence, which may positively relate to performance-approach goals, (Chen & Pajares, 2010; Hardre et al., 2007).

- Higher level of self-efficacy would positively predict both mastery and performance approach goals while negatively predicts performance avoidance goals among mathematics undergraduates. This hypothesis is informed by social cognitive theory and achievement goal research suggesting that students with stronger confidence in their mathematics capabilities are more likely to engage in challenging learning activities, persist toward achievement, and pursue competence-related goals (Bandura, 1997; Schunk, 2003). In contrast, students with lower self-efficacy are more likely to avoid situations in which they may experience failure or negative evaluation, making them more susceptible to performance-avoidance goals.
- Math growth mindset would positively mediate the relationship between perceptions of effective instructors' feedback practices and mastery goal orientation while negatively mediate the association between feedback perceptions and performance approach goals. Furthermore, math growth mindset would either positively or negatively mediate between perceived effective feedback and performance approach goal orientation. This hypothesis is based on the assumption that students who perceive instructors' feedback practices as improvement-oriented may be more likely to develop beliefs that mathematical abilities can grow through effort and learning. These beliefs, in turn, are expected to encourage adaptive motivational patterns, such as pursuing mastery and demonstrating competence,

while reducing avoidance-oriented motivational tendencies (Dweck & Leggett, 1988; Yeager & Dweck, 2012).

- Self-efficacy would positively mediate the relationship between students' perceptions of effective feedback and both mastery and performance approach goal orientation while negatively mediating the relationship between perceptions of instructors effective feedback and performance avoidance goals orientation among undergraduate mathematics students. This hypothesis is supported by research indicating that students who perceive feedback as constructive, actionable, and supportive are more likely to develop stronger confidence in their mathematical abilities (Hattie & Timperley, 2007; Schunk, 2003). Increased mathematics self-efficacy is expected to promote adaptive achievement goals focused on learning and competence demonstration, while reducing avoidance-oriented goals driven by fear of failure or low confidence.

Chapter 3: Method

Research Design

The current study is quantitative, correlational research designed to examine the relationship between perceptions of instructors' effective feedback, Math growth mindset, self-efficacy, and achievement goals among mathematics undergraduates. In this design students' perceptions of instructors' effective feedback practices serve as the independent variable, while mathematics self-efficacy is examined as mediating variables. The dependent variable is students' achievement goals orientations, including mastery goals, performance approach goals, and performance avoidance goals. The study uses a convenience sampling method to recruit participants enrolled in undergraduate mathematics courses.

Participants

Participants of this study include undergraduate freshman expected students (N = 1405) from mathematics classes (e.g., MATH 1005-Mathematical Reasoning (29 sections) and MATH 1643-Functions and Modeling (7 sections). With an average age of 18 to 26 years, enrolled at a Midwestern University. Including freshmen as study participants is valuable because they are in a critical transition phase from high school to college-level math courses, making them particularly susceptible to the influence of both personal and teacher-related factors on their achievement motivation (Rattan et al., 2012; Yeager & Dweck, 2012). Research suggests that students' early experiences in college mathematics shape their motivation, persistence, and academic self-concept, highlighting the importance of understanding how perceived math instructors' feedback impact math students' achievement goals through math growth mindset and self-efficacy beliefs (Canning et al., 2019; Rothrock, 2019; Rothrock & Gay, 2025; Wang et al., 2015).

The reason to choose these two courses includes first convenient sampling but the course syllabus was to see how these courses are suitable for the sample I am looking for in my study. Both of these courses were selected as a sampling context for this study because both courses represent foundational undergraduate mathematics experiences during a student's first year of college. The first year is a developmental period for students in which mathematics self-belief, motivation and perceptions of instructional support are especially very impactful on a student's learning. After looking at the course syllabus of both courses emphasize ongoing students' engagement, problem solving, multiple forms of assessments, assignments, exams, and instructor-student interactions within a structured classroom. MATH 1005 emphasized mathematical reasoning, communication, visualization, and conceptual understating. While MATH 1643 focuses more heavily on algebraic functions, quantitative modeling, and preparation for calculus-based coursework.

Additionally, both courses operate under a coordinated course structure in which sections share a common syllabus, assignments, grading policies, and examinations, providing consistency in instructional expectations while still allowing for natural variation in students' perceptions of instructors' feedback practices. Review of course syllabi further indicated that both courses incorporate multiple opportunities for formative and summative feedback through homework, quizzes, examinations, and classroom activities making particularly suitable settings for current study purposes.

Demographic Information

Demographic information for the current study includes participants' Name, Student ID, age, gender, race/ethnicity, and academic semester/year. For identifying the students' participation for extra credit sections and instructors' names will also be asked.

Assessment Measure

Math Specific Growth Mindset Scale (Idrees et al., 2024))

To measure students' math specific growth mindset beliefs, a math specific mindset scale developed and validated by Idrees et al. (2024) was used. The math specific growth mindset scale was developed by adapting the 8-items from the original mindset scale (Dweck 2006; Dweck, 2008; Yeager & Dweck, 2012) The scale was modified for the domain of mathematics by adding the domain name into the items. For instance, the original domain-general item, “You have a certain amount of math intelligence, and you really cannot do much to change it” was changed to "You have a certain amount of intelligence in Mathematics, and you really can’t do much to change it”. The scoring process remained the same 6-point Likert scale ranging from 1-strongly disagree, 2-disagree, 3-mostly disagree, 4-mostly agree, 5-agree, and 6-strongly agree. In the scale development study, scores demonstrated excellent internal consistency reliability (ω = .945), and confirmatory factor analysis provided evidence supporting the scale's internal structure (*CFI* = .992, *TLI* = .981, *RMSEA* = .073, 90% *CI* [.032, .112]). Additional information regarding the measure is provided in Appendix A. For more details, please see Appendix A.

Approaches to Learning Scale (DeBacker & Crowson, 2006)

To measure students' self-efficacy and achievement goals (mastery, performance approach, and performance avoidance goals), a learning approach scale consisting of 41 items were used. For this study, 24 items were selected, with 17 items measuring three types of achievement goals (i.e., mastery, performance, and avoidance) and 7 items assessing self-efficacy. Responses were recorded on a 6-point Likert scale, ranging from 1 "strongly disagree" to 6 "strongly agree". In the present study, internal consistency reliability was acceptable to good across the achievement goal subscales, with omega coefficients of .87 for mastery goals,

.86 for performance-approach goals, and .77 for performance-avoidance goals. Additional information regarding the measure is provided in Appendix B.

Perceived Teachers Effective Feedback (Carvalho et al., 2014)

Students' perceptions of teachers' effective feedback were assessed using the Questionnaire on Feedback, Identification, and School Trajectories (QFIST; Carvalho et al., 2014), which evaluates students' identification with their school, their behavioral engagement, and their perceptions of teachers' feedback. The original scale included nine items measuring effective feedback perceptions; however, for this study, eight items were used. One item was removed from the original scale, and minor wording changes were made to the remaining items (e.g., referring to "this course" instead of "this discipline") while preserving the essential meaning of the original items. These modifications were based on feedback provided by the math department chair, class coordinators, and input from my advisor as expert. To ensure that feedback perceptions are specific to students' current mathematics class, participants were instructed: "Please think about your current math instructor and math class when answering the following questions." Students responded to all items using a five-point Likert scale ranging from 1 ("It never happens in this class") to 5 ("It always happens in this class). In the present study, the scale demonstrated good internal consistency reliability ($\omega = .88$). Previous research has provided evidence supporting the reliability and validity of scores from the effective feedback subscale (Carvalho et al., 2014). For more details, please see Appendix C.

Data Collection Procedure

Data were collected from freshman undergraduate mathematics students at a Midwestern University using a survey-based quantitative method. The survey included validated scales measuring students' perceptions of instructors' feedback practices (effective vs. ineffective feedback), mathematics growth mindset, self-efficacy, and achievement goal orientations (mastery goals, performance-approach goals, and performance-avoidance goals). Prior to data collection, approval to conduct the study was obtained from the Institutional Review Board (IRB). In preparation for data collection, initial communication was established with coordinators of first-year mathematics courses through email, which included a brief description of the study purpose and a request for meetings to discuss study procedures and logistics prior to the start of the fall semester. Follow-up meetings were held with two mathematics coordinators, with additional communication continuing via email. These discussions were subsequently shared with the chair of the Mathematics Department, which led to minor revisions in the survey instrument, particularly in the wording of the feedback perception scale to better align with course structure and instructional practices.

After approximately three weeks of communication, permission was granted by the two mathematics coordinators to recruit participants, with the condition that individual instructors of each course section would provide final approval for data collection within their classes, particularly for MATH 1005. Following this, recruitment emails were sent to instructors of all 18 sections of MATH 1005 and 29 sections of MATH 1643. Ultimately, four instructors teaching seven sections of MATH 1005 agreed to participate along with 29 sections of MATH 1643. Data collection was conducted online through a Canvas announcement that included study information, informed consent, and the survey instrument, ensuring accessibility and convenience for all participants.

At the end of the semester, participant lists were shared with instructors in separate class-specific rosters to facilitate assignment of course credit. Compensation differed by course, with

MATH 1643 students receiving five extra credit points and MATH 1005 students receiving credit equivalent to one small web-based assignment.

Data Analysis Plan

Path analysis was used for this study, to examine the predictive relationships between Teachers' related factors (Perceived instructors' feedback) and student-related factors (growth mindset and self-efficacy) and how they influence mathematics students' achievement goal orientations. Preliminary analyses include descriptive statistics, correlation, and reliability testing, followed by main path analysis to assess how perceived teacher mindset and feedback impact students' motivation and achievement goals.

Why Path Analysis?

Path analysis is an appropriate statistical analysis for this study as it allows for the examination of both direct and indirect relationships among study variables of the current hypothesized process model using the lavaan package in R (Bollen, 1990; Zhang et al., 2015). Given the multiple variables involved, specifying a hypothesized model enables the assessment of how perceived teacher feedback influences math growth mindset beliefs and self-efficacy which, in turn, shapes math students' achievement goal orientations. The analysis was conducted using lavaan, which supports model fitting, hypothesis testing, and model evaluation using fit indices such as Chi-Square, *RMSEA, SRMR, CFI,* and *TLI* along with multiple estimation methods (maximum likelihood, Robust MLR etc).

Chapter 4: Results

This chapter represents the findings of the analyses conducted to examine the relationships among undergraduate math students' perceptions of instructors' effective feedback behaviors, math growth mindset, self-efficacy, and achievement goals orientations. Data was analyzed using path analysis conducted using R-package lavaan (Rosseel, 2012). The model tested both direct and indirect relationships among study variables. Particularly, perceptions of instructor's effective feedback were specified as an exogenous variable predicting math growth mindset and self-efficacy, which in turn predicted student's achievement goals (e.g., learning goals, performance approach, performance avoidance goals). The model included an error covariance between self-efficacy and growth mindset under the assumption they are related constructs both reflecting self-belief about personal control during their learning. I also specified error covariance among the three endogenous goal variables (i.e., learning, performance approach, performance avoidance) under the assumption they reflect correlated purposes behind learning in their class.

The findings are presented in the following order. First, descriptive statistics and correlations among the study variables are reported. Next, the fit of the structural model is measured. Finally, the direct and indirect effects among the study variables are presented.

Descriptive statistics, internal consistencies, and distributional characteristics

Table 1 represents the descriptive statistics, and reliability estimates for all the measurements used in the current study. This includes perception of effective feedback, math growth mindset, self-efficacy, and achievement goals (e.g., learning, performance approach, performance avoidance goals). The omega reliability coefficients (ω) for all the measurement scales ranged from .77 to .89, indicating acceptable to high internal consistency for the measures used in this current study sample.

Table 1

Descriptive Statistics of Study Variables

Variables	***ω***	***M***	***SD***	***Skewness***	***Kurtosis***
EFP	.88	3.77	.830	-.349	-304
MGM	.87	4.12	.901	.019	-.017
LG	.87	4.46	.904	-.193	.086
PAP	.86	3.34	1.12	-.412	.528
PAV	.77	2.95	1.02	.018	-.441
SE	.89	3.91	.995	.098	-.249

Note. EFP = Effective Feedback Perception, MGM = Math Growth Mindset Scale, LG = Learning Goals, PAP = Performance Approached, PAV = Performance Avoidance, SE = Self-Efficacy.

In terms of central tendency or mean score, learning goals had the highest mean score (M = 4.46, SD = 0.90), followed by math growth mindset ($M = 4.12, SD = 0.90$), self-efficacy ($M = 3.91, SD = 0.99$). Performance approach goals ($M = 3.34, SD = 1.12$) and performance avoidance ($M = 2.95, SD = 1.02$) had comparatively lower mean scores. Descriptively, these findings suggest that the math undergraduates (sample of the current study) tend to report stronger learning goals orientation than performance-oriented orientations. The values of skewness and kurtosis for all the measurements were within acceptable ranges suggesting normal distribution of all the study variables. These findings indicate that the assumptions of normality were reasonably met for following correlation and path analyses.

Table 2

Pearson Product-Moment Correlations between Study Variables

Variables	EFP	MGM	SE	LG	PAP	PAV
EFP	-	.099**	.353**	.316**	.163**	.010
MGM	-	-	.376**	.327**	-.055*	-.304**
SE	.	-	-	.421**	.238**	-.206**
LG	-	-	-	-	.295**	-.042
PAP	-	-	-	-	-	-.042
PAV	-	-	-	-	-	-

Note. EFP = Effective Feedback Perception, MGM = Math Growth Mindset Scale, LG = Learning Goals, PAP = Performance Approached, PAV = Performance Avoidance, SE = Self-Efficacy.

Table 2 displays the correlation between perceptions of instructor's effective feedback, math growth mindset belief, self-efficacy, and achievement goals orientation (i.e., learning/mastery goals, performance approach goals, and performance avoidance goals) among first year math undergraduates. The result indicates that perception of effective feedback significantly and positively correlates with math growth mindset ($r = .10$, $p < .01$) and self-efficacy beliefs ($r = .35$, $p < .01$). These findings suggest that mathematics undergraduates who reported greater experience to teacher feedback practices perceived as effective (e.g., process-oriented and constructive) indicate stronger beliefs that mathematical abilities can be developed and showed greater confidence in their capabilities to succeed in mathematics.

Additionally, the perception of effective feedback significantly and positively correlates with learning goals ($r = .32$, $p < .01$).) and performance approach goals ($r = .20$, $p < .01$). These findings suggest that mathematics undergraduates who perceive their instructors' feedback as effective, based on their experiences, report stronger orientation towards learning goals and performance approach goals. In contrast, there was no significant relationship between perceptions of effective feedback and performance avoidance goals ($r = .01$, $p > .05$).

Furthermore, the findings of the correlational analysis showed that math growth mindset beliefs significantly and positively correlated with learning goals ($r = .33$, $p < .05$) and negatively correlated with both performance approach goals ($r = -.06$, $p <.05$) and performance avoidance goals ($r = -.30$, $p <.05$). Math growth mindset was also found to be significantly and positively correlated with self-efficacy ($r = .38$, $p < .05$) among mathematics undergraduates. These findings suggest that mathematics students who hold stronger beliefs that mathematical abilities can be developed and improved through effort tend to report stronger learning goal orientations and higher levels of self-efficacy. Additionally, students with stronger math growth mindset beliefs are inclined to report lower levels of performance approach and performance avoidance goals.

Moreover, the results also showed a significant positive correlation of self-efficacy with learning goals ($r = .42$, $p <.05$) and performance approach goals ($r = .24$, $p <.05$) while it was significant and negative correlation with performance avoidance goals ($r = -.21$, $p <.05$). These findings suggest that higher levels of self-efficacy were associated with stronger learning goals and performance approach orientations, as well as lower levels of performance avoidance goals among first year mathematics students

Path analysis

Table 3 highlighted the model fitness based on different fit indices using R-package lavaan (Rosseel, 2012). To ensure that multivariate normality (which can arise even if variables are univariate normal) did not unduly influence model fit indices or standard errors, I used robust maximum likelihood estimation. The results revealed that the initial model did not fit the data very well, χ^2 (3) = 74.35, $p > .001$. Although, Robust Comparative Fit Index (*CFI* = .962) was acceptable, and the Tucker Lewis Index was below the recommended point (*TLI* = .806). Further, value of Root Mean Square Residual also indicates poor fit (*RMSEA* = .134). The Standardized Root Mean Square Residual (*SRMR* = .048) was within the acceptable limits.

Table 3

Fit Indices of the Initial Full Model and Modified Model

Fit Indices	Initial Model	Modified Final Model
Yuan-Bentler Scaled χ^2	$\chi^2(3) = 74.345$, $p = .001$	$\chi^2(2) = 21.766$, $p = .001$
Robust CFI	.961	.990
Robust TLI	.806	.921
Robust RMSEA	.134	.086
SRMR	.048	.030
AIC	17821.699	17766.864
BIC	17910.911	17861.324

After consulting the modification indices and evaluating the empirical suggestions in light of theoretical consistency, a direct path from perceived effective feedback to learning goal orientation was added (*MI* = 5.72, p < .05). This modification is also theoretically justified, as effective feedback can reasonably be expected to foster students' focus on learning and mastery. Findings from modified model indicates that although the Chi-square value was significant, $\chi^2(2)$ = 21.77, $p > .001$ but the modified model displays a clear improved fit based on other acceptable values of other indices. The Robust CFI increased to .990, indicating excellent fit, and the Robust TLI improved to .921, suggesting acceptable model fit. The RMSEA decreased to .086, which, although slightly above conventional thresholds, represents an improvement relative to the previous model. The SRMR decreased to .030, suggesting close fit of the model to the data.

Additionally, the Akaike Information Criterion (*AIC* = 17766.86) and Bayesian Information Criterion (*BIC* = 17861.32) were lower than those of the initial model (*AIC* = 17821.70; BIC = 17910.91), indicating that the modified model provided a better representation of the data relative to the initial model. Given the good fit of the revised model and its consistency with theoretical propositions, I retained this model for further interpretation.

Table 4

Prediction Values of the Tested Paths (Direct Effects)

Paths	*B*	*SE*	*p*	*β*
Direct Effects				
Effective Feedback Perception → Math Growth Mindset	.110	.031	.000	.010
Effective Feedback Perception → Self-Efficacy	.430	.031	.000	.410
Effective Feedback Perception → Learning Goals	.201	.030	.000	.190
Math Growth Mindset → Learning Goals	.202	.031	.000	.204
Math Growth Mindset → Performance Approach Goals	-.210	.040	.000	-.170
Math Growth Mindset → Performance Avoidance Goals	-.250	.033	.000	-.220
Self-Efficacy → Learning Goals	.250	.030	.000	.280
Self-Efficacy → Performance Approach Goals	.340	.032	.000	.301
Self-Efficacy → Performance Avoidance Goals	-.230	.030	.000	-.224

Note. *$p < .05$, **$p < .01$, ***$p < .001$. B = unstandardized regression slope. β = fully standardized regression slope.

Table 4 contains the unstandardized and standardized direct effects among effective feedback perceptions, math growth mindset, self-efficacy, and achievement goals orientations. The findings revealed that effective feedback perceptions significantly and positively predicted math growth mindset, self-efficacy and learning goals among math undergraduates. Math growth mindset belief was found to be positive and significant predictor of learning goals, while significant and negative predictor of performance approach and performance avoidance goals. Similarly, self-efficacy significantly and positively predicted learning and performance approach goals, while negatively predicting performance avoidance goals.

Table 5

Unstandardized Residual Covariances and Correlations

Variables	*B*	*SE*	*p*	*β*	*r*
Math Growth Mindset ↔ Self-Efficacy	.310	.026	.000	.400	.376**
Learning Goals ↔ Performance Approach Goals	.210	.026	.000	.301	.238**
Learning Goals ↔ Performance Avoidance Goals	.104	.024	.000	.130	-.206**
Performance Approach Goals ↔ Performance Avoidance Goals	.710	.033	.000	.644	-.042

Note. *$p < .05$, **$p < .01$, ***$p < .001$. B = unstandardized regression slope. β = fully standardized regression slope. r = correlation.

Table 5 above indicates the error covariances I specified for model modifications. The findings indicate a significant relationship among motivational constructs, particularly a strong relationship between growth mindset and self-efficacy.

Mediation Tests

I performed mediation analyses to test the indirect effects of effective feedback perception on achievement goal orientations through both math growth mindset and self-efficacy. During mediation analysis, indirect effects are computed as the product of path coefficients following the tracing rule from an antecedent variable to a consequent (see Hayes, 2022) via proposed mediators. The default test of the indirect effect in Lavaan relies on the Delta Method, which is functionally equivalent to the Sobel test. This method assumes a normal sampling distribution of the indirect effect (Hayes, 2022), which is not typically achievable with smaller samples. However, given the large size of my sample, asymptotic normality justifies the use of this approach during this analysis.

Table 6 below contains the indirect effects and significance test for each tracing between effective feedback and each achievement goal. Effective feedback perception showed a significant indirect effect on learning goals through math growth mindset and self-efficacy. Similarly, effective feedback perception demonstrates a significant negative indirect effect on performance approach goals through math growth mindset and positive indirect effect through self-efficacy. Additionally, effective feedback perception was found to have a significant negative indirect effect on performance avoidance goals through both math growth mindset and self-efficacy. These results suggest that both math growth mindset and self-efficacy significantly mediate the relationship between effective feedback perceptions and students' achievement goal orientations, with self-efficacy demonstrating a stronger mediating role than math growth mindset.

Table 6

Indirect Effects and Significance Tests

Tracing	*B*	*SE*	*p*	*β*
Effective Feedback → Math Growth Mindset → Learning Goals	.022	.010	.002	.020
Effective Feedback → Math Growth Mindset → Performance Approach Goals	-.030	.010	.001	-.022
Effective Feedback → Math Growth Mindset → Performance Avoidance Goals	-.023	.010	.002	-.020
Effective Feedback → Self-efficacy → Learning Goals	.110	.020	.000	.101
Effective Feedback → Self-efficacy → Performance Approach Goals	.144	.020	.000	.110
Effective Feedback → Self-efficacy → Performance Avoidance Goals	-.100	.013	.000	-.100

Note. $^*p < .05$, $^{**}p < .01$, $^{***}p < .001$. B = unstandardized indirect effect. β = fully standardized indirect effect.

Chapter 5: Discussion

The purpose of the current study was to examine to what extent undergraduate mathematics students' perceptions of their instructors' effective feedback practices predicted their achievement goals orientation through mediational roles of math growth mindset and self-efficacy. Based on different motivational theoretical perspectives (Bandura, 1997; Dweck & Leggett, 1988; Elliot & McGregor, 2001; Hattie & Timperley, 2007; Lipenvich & Smith, 2022) the current study investigated the direct and indirect relationships among students' perceptions of effective instructors' feedback practices, mathematics growth mindset, self-efficacy and achievement goals among first year mathematics undergraduates. This study addressed two main research questions: (a): Is students' perception of instructors' effective feedback practices related to mindset beliefs, self-efficacy, and achievement goal orientations in math classes? (b) Do growth mindset and self-efficacy mediate the relationship between students' perceptions of instructors' effective feedback practices and their achievement goal orientations?

Considering theoretical and empirical evidence, it was hypothesized that perceptions of effective instructors' feedback practices would positively predict mathematics growth mindset and self-efficacy which in turn would positively predict mastery and negatively predict performance avoidance goals, while either positive or negative prediction would be expected with performance approach goals. It was also hypothesized that math growth mindset and self-efficacy would play a significant mediational relationship between effective feedback perceptions and achievement goals orientations. To examine these relationships, correlational and path analyses were conducted using the data collected from first year mathematics undergraduates enrolled in foundational mathematics courses. Overall findings from the correlational and path analyses supported the proposed theoretical model although some findings were slightly different from initial expectations.

Correlational Analyses

In this study it was hypothesized there would be relationships between effective feedback perceptions and math growth mindset, self-efficacy, and achievement goal orientations. Findings show consistency with prior literature emphasizing that supportive and process-oriented feedback practices perceived by students enhance their motivational beliefs and adoption of adaptive goals orientation (Hattie & Timperley, 2007; Koenka et al., 2021; Schunk, 2003). The findings from the current study suggest that when students' perceived feedback practices as effective it enhances their self-efficacy and their growth mindset beliefs about mathematics (Dweck, 2006; Yeager & Dweck, 2012). A significant but small magnitude of correlation between perceived effective feedback and math growth mindset might indicate that growth mindset belief is influenced by multiple developmental and contextual factors (Parental expectations, cultural stereotypes, different contexts etc.) as suggested by previous studies (Jacob et al., 2017; McKinney et al., 2009; Pajares & Miller, 1997; Xie et al., 2023). In current study the focus is on one factor, one context and teacher at a time which might have caused a weaker association.

On the other hand, perceptions of effective feedback found to have stronger association with self-efficacy as compared to math growth mindset. It means students' perceived feedback practices as effective, process oriented, supportive, and informative help students to boost their self-confidence on their abilities to engage in mathematical tasks and overcome difficulties (Harks et al., 2014; Mueller & Dweck, 1998). These findings are also aligned with Bandura (1997) self-efficacy theory, particularly, focusing on verbal persuasion and performance related feedback as important sources of self-efficacy. The stronger correlation between effective feedback perceptions and self-efficacy compared to mathematics growth mindset might be because of conceptual differences between two constructs. Self-efficacy reflects more immediate judgment of someone's capability to perform certain tasks successfully while growth mindset reflects a broader belief system regarding malleability of mathematical ability. Therefore, one possible justification might be that classroom feedback is often tied to recent performance and task completion, which makes it more likely to influence students' confidence in their competence (self-efficacy) than growth mindset beliefs. The correlational findings were further supported by the path analyses below.

Path Analysis (Direct Paths)

Effective Feedback Perceptions, Math Growth Mindset and Self-efficacy

Supported by previous studies, current findings indicate that effective feedback perception positively predicted both mathematics growth mindset and self-efficacy (Hattie & Timperley, 2007; Koenka et al., 2021; Shute, 2008). These findings suggest that students perceived their instructors' feedback practices as effective, efforts oriented, supportive, process-based contribute to enhance self-confidence and growth mindset beliefs among mathematics undergraduates (Harks et al., 2914; Kyaruzi et al., 2019; Muthukrishnan et al., 2024).

Additionally, these findings are also inclined with the Lipnevich and Smith (2022) feedback framework which focuses on effectiveness of feedback depending on how students perceive and interpret the feedback practices of instructors rather than how feedback is being delivered. Overall, these findings fully support the hypothesis of the current study by highlighting the first-year mathematics students who might have already existing anxieties about their math abilities and if they perceived their instructors' feedback as supportive and process-oriented it might help them to overcome anxieties by boosting confidence in their math capabilities and mathematical abilities.

Mathematics, Growth, Mindset and Achievement Goals

In this study, it was hypothesized that mathematics growth mindset beliefs would positively predict both mastery and negatively predict performance avoidance goals. While either negative or positive predictive relationship with performance avoidance goals due to inconsistent findings about this relationship in prior literature (Chen & Wong, 2015; Schwinger et al., 2016). The findings showed consistency with the hypothesis by showing a negative association between math growth mindset and performance approach goals while a positive prediction between math growth mindset and mastery goals. Although, some studies reported that students with growth mindset may simultaneously pursue both mastery and performance approach goals (Burnette et al., 2013; Burnette et al., 2020; Dickhäuser et al., 2016; Molden & Dweck, 2000; Yu & McLellan, 2020). The current findings strongly connected with traditional mindset theory suggesting that growth mindset beliefs are associated with mastery goals orientation (Blackwell et al., 2007; Dweck & Elliott, 1983).

Another exolaintion about these findings might be possibility that students with stronger mathematics growth mindset beliefs may have viewed academic success more in terms of efforts, self-improvement, and conceptual understanding rather than outperforming others particularly within the mathematics context. Another possible reason/explanation might be that mathematics growth mindset scales (domain specific) have been extensively used in K-12 settings, in current study the scale is developed and used for undergraduate students who may have interpreted the items differently emphasizing personal growth over competence demonstration. This difference in interpretation may be a reason for the negative association between math growth mindset and performance approach goals among mathematics undergraduates. At the same time negative association between mathematics growth mindset and performance approach goals is theoretically consistent with previous studies suggesting students with growth mindset are less likely to fear failure and take mistakes as opportunity to learn (Yeager & Dweck, 2012).

Self-Efficacy and Achievement Goals Orientation

Self-efficacy is found as one of the strongest and positive predictors of mastery and performance approach goal within the correlational analyses of current study. Results of this study indicated that the self-efficacy was significantly and positively associated with both mastery and performance approach goals while, negatively associated with performance avoidance goals supporting the current study hypothesis. Previous literature and self-efficacy theory strongly support these findings by suggesting that students with higher self-efficacy are more likely to engage in challenging tasks, persist during difficulties, less scared of failure, and adopt both mastery and performance approach goals (Alhadabi & Karpinski, 2020; Bandura, 1997; Hardre et al., 2007; Pajares & Cheong, 2003; Walker & Greene, 2009). The positive association of self-efficacy with performance approach goals might also indicate that students with higher levels of self-confidence may also feel comfortable demonstrating competence relative to peers because they anticipate successful performance outcomes to further boost confidence. While negative association of self-efficacy with performance avoidance goals is also theoretically and empirically supported as students with high self-efficacy are less likely to adopt avoidance-oriented goals as they believe on their competence (Huang, 2011; Hulleman et al., 2010; Schunk, 2003).

Concluding to direct path analyses findings self-efficacy importantly emerged as one of the strongest predictors within the final model, highlighting the central role of competence beliefs in developing achievement motivation among undergraduate mathematics students as supported by Bandura's (1997) perspective that self-efficacy influences students' persistence, emotional responses, and engagement during challenging academic situations.

Mediational Analyses (Indirect Paths)

In the current study to understand the mediational role of mathematics growth mindset and self-efficacy between students' perceptions of instructors' effective feedback practices and achievement goals, indirect effects were analyzed. It was hypothesized that mathematics growth mindset and self-efficacy would mediate the relationship between effective feedback perceptions and achievement goal orientations (i.e., mastery, performance approach, and performance avoidance). Results from the current study fully support the hypothesis by revealing that math growth mindset positively mediate between effective feedback perceptions and learning goals while negatively mediate between effective feedback perceptions and performance approach and avoidance goals.

Consistent with the hypotheses and prior theoretical perspectives, mathematics growth mindset beliefs and self-efficacy positively mediated the relationship between perceived effective feedback and mastery goals. These results reported that when mathematics students perceive instructors' feedback as effective, it may strengthen their beliefs that mathematical abilities can be improved through efforts and learning while also reinforcing their self-efficacy beliefs in performing mathematics tasks. In turn, these beliefs may appear to promote greater focus on learning, persistence and competence development. These findings are supported by growth mindset theory, student feedback model, and previous literature suggesting that feedback emphasizing improvement and learning processes contributes to adaptive beliefs regarding competence and achievement (Bandura, 1997; Burnette et al., 2013; Burnette et al., 2020; Dweck

& Leggett, 1988; Hattie & Timperley, 2007; Koenka et al., 2021; Lipnevich & Smith, 2022; Mueller & Dweck, 1998; Schunk, 2003; Yeager & Dweck, 2012).

Interestingly, in this study, self-efficacy was found to be stronger predictor than math growth mindset consistent with some prior studies reporting self-efficacy as mediator between teachers’ feedback practices and achievement goal orientations (Ahmed et al., 2021; Hulleman et al., 2010; Gibbs & Simpson, 2005). One possible explanation is that self-efficacy beliefs are more context- and state dependent and malleable motivational belief than growth mindset. As according to Bandura (1997) self-efficacy is closely tied to students’ ongoing classroom mastery experiences, verbal persuasion, performance evaluations, and other classroom experiences, allowing self-efficacy to change relatively quickly in response to instructional practices. As a result, students' confidence in their ability to perform mathematics tasks is likely to be influenced by the feedback they receive during day-to-day classroom interactions. In contrast, growth mindset reflects a broader belief about the malleability of one's mathematical ability that tends to develop over a longer period through accumulated experiences and may therefore be less responsive to individual feedback experiences. Consequently, students' perceptions of their instructors' feedback practices may have a more immediate and direct influence on mathematics self-efficacy than on mathematics growth mindset, helping to explain why self-efficacy emerged as the stronger mediator in the present study.

Additionally, the negative mediational role of mathematics growth mindset beliefs between perceived effective feedback and performance-approach goals may be explained by the process-oriented and improvement-focused nature of effective feedback in the current study. Students who internalized such feedback may have focused more on learning, persistence, and conceptual understanding rather than social comparison or external competence validation.

Similar findings have been reported in previous studies suggesting that growth mindset beliefs do not always positively predict performance-oriented goals, particularly when students define success in mastery-oriented rather than comparative terms (Chen & Wong, 2015; Schwinger et al., 2016).

Lastly, both mathematics growth mindset and self-efficacy were found to negatively mediate the relationship between perceived effective feedback and performance avoidance goals, supporting the current study hypothesis and previous empirical evidence (Elliot & McGregor, 2001; Huang, 2011; Hardre et al., 2007). These findings might recommend that mathematics students who perceived instructor feedback as effective may develop stronger confidence in their capabilities and beliefs about malleability of their math ability which make them less fearful of failure, less concerned about appearing incompetent, and less likely to avoid challenges.

Theoretical and Practical Implications

The current study is both theoretically and practically significant, as it highlights the role of students' perceptions of instructor feedback practices in shaping motivational outcomes within mathematics education. Practically, the findings may help educators better understand how students interpret feedback practices and how these perceptions relate to mathematics growth mindset, self-efficacy, and achievement goal orientations. This understanding may support the development of instructional and feedback practices that foster students' motivation and engagement in mathematics learning contexts. This, in turn, informs educators on how to use feedback to enhance students' growth mindset beliefs, self-efficacy, and achievement motivation.

Theoretically, this study contributes to the existing literature on feedback, achievement motivation, and student learning by investigating the mediating roles of growth mindset beliefs and self-efficacy, in the relationship between students' perceptions of instructor's feedback practices and achievement goal orientations, particularly among mathematics undergraduates.

Apart from that, in contrast to prior research that feedback practices on instructors' delivery of feedback or evaluates feedback as effective or ineffective, the focus of this study is on students' perceptions of instructors' effective feedback, rather than instructors' delivery of feedback. By highlighting the central role of perceptions as the primary mechanism through which feedback influences motivation, this study contributes to an advancement in feedback and motivation theories (Hattie & Timperley, 2007; Lipnevich & Smith, 2022; Mandouit & Hattie, 2023). Additionally, no study to date has been conducted to investigate the positive mechanism of how mathematics undergraduates' perceptions of effective instructor feedback impact their achievement motivation through the mediational roles of math growth mindset and self-efficacy. Therefore, this study contributes to the growing literature on domain-specific motivational processes in mathematics education.

Limitations and Suggestions

There were some possible limitations of the current study which are following. First, the representativeness of the sample of current study may limit the generalizability of the findings. Participants consisted primarily of first year undergraduates enrolled in foundational mathematics courses at a single Midwest University. Although this population was particularly important for this study, first year mathematics experiences often play a critical role in developing students' motivational beliefs and learning outcomes. The findings may not be necessarily generalized to other mathematics student populations, upper-level math courses, students from different institutes, and students from different cultural and educational contexts. It might be possible students enrolled in upper-level math courses may experience effective feedback, self-efficacy, and achievement goals differently due to greater experience from different instructional environments. Therefore, future studies should focus on different classrooms and higher-level mathematics courses to cross-validate the findings across different mathematics and STEM student populations. Additionally, future research should examine whether the proposed model generalizes to other academic domains where mathematics is core course (e.g., physics engineering, and chemistry etc.) to determine whether the observed relationships are unique to mathematics or are applicable across different educational contexts.

Second, all study variables were assessed using self-reported instruments, which may raise concerns related to common method variance, social desirability bias, and subjective interpretation of survey items. Additionally, although the mathematics specific growth mindset scale was strongly reliable, it was a relatively new domain-specific measure developed for undergraduate mathematics students, therefore, there might be additional validation across upper-level mathematics undergraduate populations.

Third, this study only focuses on effective feedback perceptions, findings might have differences by looking at the ineffective feedback impact at the same time on student's motivation and achievement orientation. Therefore, future studies should have items for ineffective feedback to see the differences in effective and ineffective feedback perceptions.

Another important limitation involves the inability to analytically account for clustering of students within classrooms due to recording errors involving classroom identifiers. Future studies should explicitly address classroom clustering through multilevel modeling.

Finally, the current study is totally quantitative in nature and focuses exclusively on students' perceptions of instructor effective feedback. Future research could incorporate both teacher-reported feedback and student-perceived feedback via longitudinal or experimental studies to provide a more comprehensive understanding of effective feedback perceptions and effects on students' achievement motivation. In particular, observational methods could be used to document the actual frequency of instructors' feedback behaviors that are theoretically associated with effective feedback and to compare these observations with students' perceptions of those behaviors. Such a multimethod approach would help determine the extent to which students' perceptions correspond with instructors' observed feedback practices while reducing the limitations associated with relying solely on self-report measures. Additionally, longitudinal and experimental research designs are needed to better understand the mechanisms underlying these relationships and how they develop over time. Additionally, longitudinal and experimental studies might be needed to better understand the mechanism and developmental nature of these relationships over time.

Conclusion

The current study examined how undergraduate mathematics students' perceptions of instructors' effective feedback practices relate to their achievement goals orientations through mathematics growth mindset and self-efficacy. Overall, findings revealed that mathematics undergraduates who perceived their instructor's feedback as supportive, clear, constructive process and improvement-oriented reported stronger self-efficacy and mathematics growth mindset beliefs. These beliefs in turns were found to be associated with more adaptive achievement goals. Importantly, self-efficacy emerged as one of the strongest predictors of achievement goals, highlighting the central role of competence beliefs within mathematical learning contexts. These findings were aligned with theoretical perspectives that feedback influences motivation not only directly, but also indirectly through students' beliefs about their abilities and competence. With several limitations, this study contributes to the growing literature on feedback perceptions, motivational beliefs, and achievement goals by providing a more comprehensive understanding of how students' perceptions of instructional feedback shape achievement motivational patterns among first year mathematics undergraduates.

References

Adams, A. M., Wilson, H., Money, J., Palmer-Conn, S., & Fearn, J. (2020). Student engagement with feedback and attainment: the role of academic self-efficacy. *Assessment &* Evaluation in Higher Education, 45(2), 317-329. https://doi.org/10.1080/02602938.2019.1640184

Ahmed, M., Thomas, M., & Farooq, R. (2021). The impact of teacher feedback on students' academic performance: A mediating role of self-efficacy. *Journal of Development and Soci*al Sciences, 2(3), 464-480. https://doi.org/10.47205/jdss.2021(2-iii)39

Al-Darei, I. S., & Elhag, A. (2022). The effect of feedback type in the e-learning environment on students' achievement and motivation. *Journal of Educational Technology and Online Lear*ning, *5(3), 694-705*.https://doi.org/10.31681/jetol.1111527

Alhadabi, A., & Karpinski, A. C. (2020). Grit, self-efficacy, achievement orientation goals, and academic performance in University students. *International Journal of Adolescence and Youth, 25(1), 519-535.* https://doi.org/10.1080/02673843.2019.1679202

Ashcraft, M. H., & Moore, A. M. (2009). Mathematics anxiety and the affective drop in performance. *Journal of Psychoeducational assessment, 27(3), 197-* 205.https://doi.org/10.1177/0734282908330580

Ayotola, A., & Adedeji, T. (2009). The relationship between mathematics self-efficacy and achievement in mathematics. *Procedia-Social and Behavioral Sciences, 1(1), 953-957.* https://doi.org/10.1016/j.sbspro.2009.01.169

Baadte, C., & Schnotz, W. (2014). Feedback effects on performance, motivation and mood: Are they moderated by the learner's self-concept?. *Scandinavian Journal of Educational* Research, 58(5), 570-591.https://doi.org/10.1080/00313831.2013.781059

Bai, B., & Wang, J. (2023). The role of growth mindset, self-efficacy and intrinsic value in self-regulated learning and English language learning achievements. *Language teaching research, 27(*1), 207-228. https://doi.org/10.1177/1362168820933190

Bandura, A. (1997). *Self-efficacy: The exercise of control*. Mac*millan. https://doi.org/10.4324/9781315800820-2*

Beilock, S. L., & Maloney, E. A. (2015). Math anxiety: A factor in math achievement not to be ignored. *Policy Insights from the Behavioral and Brain Sciences,* 2(1), 4-12. https://doi.org/10.1177/2372732215601438

Beilock, S. L., & Maloney, E. A. (2015). Math anxiety: A factor in math achievement not to be ignored. *Policy Insights from the Behavioral and Brain Sciences,* 2(1), 4-12. https://doi.org/10.1177/2372732215601438

Berry, D. N., Taylor, M. L., Nicolai, K. D., Koenka, A. C., Barnes, N., de Oliveira, L. C., & Zumbrunn, S. (2025). Reading and writing feedback perceptions among multilingual and monolingual learners across K-20 contexts: A systematic review. *Learning and Instruct*ion, 95, 102022. https://doi.org/10.1016/j.learninstruc.2024.102022

Bilbro, J., Iluzada, C., & Clark, D. E. (2013). Responding effectively to composition students: Comparing student perceptions of written and audio feedback. *Journal on Excellence in College* Teaching, 24(1).https://doi.org/10.4324/9781410611505-9

Blackwell, L. S., Trzesniewski, K. H., & Dweck, C. S. (2007). Implicit theories of intelligence predict achievement across an adolescent transition: A longitudinal study and an intervention. *Child development,* 78(1), 246-263. https://doi.org/10.1111/j.1467-8624.2007.00995.x

Boaler, J. (2016). Designing mathematics classes to promote equity and engagement. *The Journal of Mathematical Behavior*, 41, 172-178. https://doi.org/10.1016/j.jmathb.2015.01.002

Bollen, K. A. (1990). A comment on model evaluation and modification. *Multivariate Behavioral Research*, *25*(2), 181-185. https://doi.org/10.1207/s15327906mbr2502_5

Bragg, L. A., Herbert, S., Loong, E. Y. K., Vale, C., & Widjaja, W. (2016). Primary teachers notice the impact of language on children's mathematical reasoning. *Mathematics Education Research Journal*, *28*(4), 523-544. https://doi.org/10.1007/s13394-016-0178-y

Brookhart, S. M. (2008). Feedback that fits.https://doi.org/10.4324/9781315627502-4

Brookhart, S. M. (2017). How to give effective feedback to your students. Ascd.https://doi.org/10.4324/9781315627502-3

Brown, G. T., Peterson, E. R., & Yao, E. S. (2016). Student conceptions of feedback: Impact on self-regulation, self-efficacy, and academic achievement. *British Journal of Educational Psychology,* 86(4), 606-629. https://doi.org/10.1111/bjep.12126

Burnette, J. L., Billingsley, J., Banks, G. C., Knouse, L. E., Hoyt, C. L., Pollack, J. M., & Simon, S. (2023). A systematic review and meta-analysis of growth mindset interventions: For whom, how, and why might such interventions work?. *Psychological bulletin,* 149(3-4), 174. https://doi.org/10.1037/bul0000368

Burnette, J. L., Knouse, L. E., Vavra, D. T., O Boyle, E., & Brooks, M. A. (2020). Growth mindsets and psychological distress: A meta-analysis. *Clinical Psychology Review*, 77, 101816. https://doi.org/10.1016/j.cpr.2020.101816

Burnette, J. L., O boyle, E. H., VanEpps, E. M., Pollack, J. M., & Finkel, E. J. (2013). Mind-sets matter: a meta-analytic review of implicit theories and self-regulation. *Psychological bulletin*, *139*(3), 655.https://doi.org/10.1037/a0029531

Canning, E. A., Ozier, E., Williams, H. E., AlRasheed, R., & Murphy, M. C. (2022). Professors who signal a fixed mindset about ability undermine women's performance in STEM. *Social Psychological and Personality Science*, *13*(5), 927-937. https://doi.org/10.1177/19485506211030398

Capa-Aydin, Y. (2016). Student evaluation of instruction: comparison between in-class and online methods. *Assessment & Evaluation in Higher Education*, *41*(1), 112-126. https://doi.org/10.1080/02602938.2014.987106

Carvalho, C., Santos, J., Conboy, J., & Martins, D. (2014). Teachers' feedback: Exploring differences in students' perceptions. *Procedia-Social and Behavioral Sciences*, *159*, 169-173. https://doi.org/10.1016/j.sbspro.2014.12.351

Chan, J. C., & Lam, S. F. (2010). Effects of different evaluative feedback on students' self-efficacy in learning. *Instructional Science, 38(1), 37-58.* https://doi.org/10.1007/s11251-008-9077-2

Chen, J. A., & Pajares, F. (2010). Implicit theories of ability of Grade 6 science students: Relation to epistemological beliefs and academic motivation and achievement in science. *Contemporary educational psychology*, *35*(1), 75-87. https://doi.org/10.1016/j.cedpsych.2009.10.003

Chen, W. W., & Wong, Y. L. (2015). Chinese mindset: Theories of intelligence, goal orientation and academic achievement in Hong Kong students. *Educational Psychology*, *35*(6), 714-725. https://doi.org/10.1080/01443410.2014.893559

Church, M. A., Elliot, A. J., & Gable, S. L. (2001). Perceptions of classroom environment, achievement goals, and achievement outcomes. *Journal of educational psychology*, *93*(1), 43.https://doi.org/10.1037/0022-0663.93.1.43

Claro, S., Paunesku, D., & Dweck, C. S. (2016). Growth mindset tempers the effects of poverty on academic achievement. *Proceedings of the National Academy of Sciences, 113(31), 8664-8668*. https://doi.org/10.1073/pnas.1608207113

Cutumisu, M., & Lou, N. M. (2023). The roles of generic and domain-specific mindsets in learning graphic design principles. *Interactive Learning Environments*, *31*(3), 1781-1795.https://doi.org/10.1080/10494820.2020.1857787

Daumiller, M., Grassinger, R., Dickhauser, O., & Dresel, M. (2016). Structure and relationships of university instructors' achievement goals. *Frontiers in Psychology*, *7*, 375.https://doi.org/10.3389/fpsyg.2016.00375

De Kraker-Pauw, E., Van Wesel, F., Krabbendam, L., & Van Atteveldt, N. (2017). Teacher mindsets concerning the malleability of intelligence and the appraisal of achievement in the context of feedback. *Frontiers in Psychology*, *8*, 1594. https://doi.org/10.3389/fpsyg.2017.01594

DeBacker, T. K., & Crowson, H. M. (2006). Influences on cognitive engagement: Epistemological beliefs and need for closure. *British Journal of Educational Psychology*, *76*(3), 535-551.https://doi.org/10.1348/000709905x53138

Dickhauser, O., Dinger, F. C., Janke, S., Spinath, B., & Steinmayr, R. (2016). A prospective correlational analysis of achievement goals as mediating constructs linking distal motivational dispositions to intrinsic motivation and academic achievement. *Learning and Individual Differences*, *50*, 30-41.https://doi.org/10.1016/j.lindif.2016.06.020

Dweck, C. S. (2008). Can personality be changed? The role of beliefs in personality and change. *Current directions in psychological science*, *17*(6), 391-394. https://doi.org/10.1111/j.1467-8721.2008.00612.x

Dweck, C. S. (2024). Personal perspectives on mindsets, motivation, and psychology. *Motivation Science*, *10*(1), 1.https://doi.org/10.1037/mot0000304

Dweck, C. S., & Leggett, E. L. (1988). A social-cognitive approach to motivation and personality. *Psychological review*, *95*(2), 256. https://doi.org/10.1037/0033-295x.95.2.256

Dweck, C. S., & Molden, D. C. (2000). Self theories. *Handbook of competence and motivation*, 122-140. https://doi.org/10.1016/b978-012619070-0/50028-3

Dweck, C. S., & Yeager, D. S. (2019). Mindsets: A view from two eras. *Perspectives on Psychological science*, *14*(3), 481-496.https://doi.org/10.1177/1745691618804166

Dweck, C. S., Walton, G. M., & Cohen, G. L. (2014). Academic tenacity: Mindsets and skills that promote long-term learning. *Bill & Melinda Gates Foundation*.

Ekholm, E., Zumbrunn, S., & Conklin, S. (2015). The relation of college student self-efficacy toward writing and writing self-regulation aptitude: Writing feedback perceptions as a mediating variable. *Teaching in Higher Education*, *20*(2), 197-207. https://doi.org/10.1080/13562517.2014.974026

Elliot, A. J. (1999). Approach and avoidance motivation and achievement goals. *Educational psychologist*, *34*(3), 169-189.https://doi.org/10.1207/s15326985ep3403_3

Elliot, A. J., & McGregor, H. A. (2001). A 2× 2 achievement goal framework. *Journal of personality and social psychology*, *80*(3), 501. https://doi.org/10.1037/0022-3514.80.3.501

Elliot, A. J., & Murayama, K. (2008). On the measurement of achievement goals: critique, illustration, and application. *Journal of educational psychology*, *100*(3), 613. https://doi.org/10.1037/0022-0663.100.3.613

Elliott, E. S., & Dweck, C. S. (1983). Achievement motivation. *Handbook of child psychology: social and personality development. New York: Wiley*, 643-691. https://doi.org/10.1037/0022-3514.54.1.5

Elliott, E. S., & Dweck, C. S. (1983). Achievement motivation. *Handbook of child psychology: social and personality development. New York: Wiley*, 643-691.https://doi.org/10.1037/0022-3514.54.1.5

Elliott, E. S., & Dweck, C. S. (1988). Goals: an approach to motivation and achievement. *Journal of personality and social psychology*, *54*(1), 5. https://doi.org/10.1037/0022-3514.54.1.5

Fast, L. A., Lewis, J. L., Bryant, M. J., Bocian, K. A., Cardullo, R. A., Rettig, M., & Hammond, K. A. (2010). Does math self-efficacy mediate the effect of the perceived classroom environment on standardized math test performance?. *Journal of educational psychology*, *102*(3), 729. https://doi.org/10.1037/a0018863

Ferris, D. R., Liu, H., Sinha, A., & Senna, M. (2013). Written corrective feedback for individual L2 writers. *Journal of second language writing*, *22*(3), 307-329.https://doi.org/10.1016/j.jslw.2012.09.009

Finn, B., Thomas, R., & Rawson, K. A. (2018). Learning more from feedback: Elaborating feedback with examples enhances concept learning. *Learning and Instruction*, *54*, 104-113. https://doi.org/10.1016/j.learninstruc.2017.08.007

Fong, C. J., Patall, E. A., Vasquez, A. C., & Stautberg, S. (2019). A meta-analysis of negative feedback on intrinsic motivation. *Educational Psychology Review*, *31*(1), 121-162.https://doi.org/10.1007/s10648-018-9446-6

Furnham, A. (2014). Increasing your intelligence: Entity and incremental beliefs about the multiple "intelligences". *Learning and Individual Differences*, *32*, 163-167. https://doi.org/10.1016/j.lindif.2014.03.001

Furtak, E. M., Ruiz-Primo, M. A., Shemwell, J. T., Ayala, C. C., Brandon, P. R., Shavelson, R. J., & Yin, Y. (2008). On the fidelity of implementing embedded formative assessments and its relation to student learning. *Applied measurement in education*, *21*(4), 360-389.https://doi.org/10.1080/08957340802347852

Gan, Z., He, J., Zhang, L. J., & Schumacker, R. (2023). Examining the relationships between feedback practices and learning motivation. *Measurement: Interdisciplinary Research and Perspectives*, *21*(1), 38-50. https://doi.org/10.1080/15366367.2022.2061236

Gibbs, G., & Simpson, C. (2005). Conditions under which assessment supports students' learning. Learning and teaching in higher education, (1), 3-31. https://doi.org/10.4324/9780203479292-13

Grant, H., & Dweck, C. S. (2003). Clarifying achievement goals and their impact. *Journal of personality and social psychology*, *85*(3), 541. https://doi.org/10.1037/0022-3514.85.3.541

Greene, B. A., Miller, R. B., Crowson, H. M., Duke, B. L., & Akey, K. L. (2004). Predicting high school students' cognitive engagement and achievement: Contributions of classroom perceptions and motivation. *Contemporary educational psychology*, *29*(4), 462-482.https://doi.org/10.1016/j.cedpsych.2004.01.006

Grootenboer, P., & Hemmings, B. (2007). Mathematics performance and the role played by affective and background factors peter grootenboer and brian hemmings. *Mathematics education research journal*, *19*(3), 3-20. https://doi.org/10.1007/bf03217459

Grootenboer, P., & Hemmings, B. (2007). Mathematics performance and the role played by affective and background factors peter grootenboer and brian hemmings. *Mathematics education research journal*, *19*(3), 3-20. https://doi.org/10.1007/bf03217459

Gunderson, E. A., Park, D., Maloney, E. A., Beilock, S. L., & Levine, S. C. (2018). Reciprocal relations among motivational frameworks, math anxiety, and math achievement in early elementary school. *Journal of Cognition and Development*, *19*(1), 21-46. https://doi.org/10.1080/15248372.2017.1421538

Hackett, G., & Betz, N. E. (1995). Self-efficacy and career choice and development. In *Self-efficacy, adaptation, and adjustment: Theory, research, and application* (pp. 249-280). Boston, MA: Springer US.https://doi.org/10.1007/978-1-4419-6868-5_9

Hardre, P. L., Crowson, H. M., Debacker, T. K., & White, D. (2007). Predicting the academic motivation of rural high school students. *The Journal of Experimental Education*, *75*(4), 247-269.https://doi.org/10.3200/jexe.75.4.247-269

Harks, B., Rakoczy, K., Hattie, J., Besser, M., & Klieme, E. (2014). The effects of feedback on achievement, interest and self-evaluation: the role of feedback's perceived usefulness. *Educational Psychology*, *34*(3), 269-290. https://doi.org/10.1080/01443410.2013.785384

Harlow, L., DeBacker, T., & Crowson, H. M. (2011). Need for closure, achievement goals, and cognitive engagement in high school students. *The Journal of Educational Research*, *104*(2), 110-119.https://doi.org/10.1080/00220670903567406

Hattie, J. (2009). The black box of tertiary assessment: An impending revolution. *Tertiary assessment & higher education student outcomes: Policy, practice & research*, *259*, 275.https://doi.org/10.3726/978-3-653-04632-8/14

Hattie, J. (2012). *Visible learning for teachers: Maximizing impact on learning*. Routledge. https://doi.org/10.4324/9780203181522-6

Hattie, J., & Timperley, H. (2007). The power of feedback. *Review of educational research*, *77*(1), 81-112.https://doi.org/10.3102/003465430298487

Havnes, A., Smith, K., Dysthe, O., & Ludvigsen, K. (2012). Formative assessment and feedback: Making learning visible. *Studies in educational evaluation*, *38*(1), 21-27.https://doi.org/10.1016/j.stueduc.2012.04.001

He, J., Liu, Y., Ran, T., & Zhang, D. (2023). How students' perception of feedback influences self-regulated learning: The mediating role of self-efficacy and goal orientation. *European Journal of Psychology of Education*, *38*(4), 1551-1569. https://doi.org/10.1007/s10212-022-00654-5

Hill, L., & Edwards, F. (2019). Student perceptions of their involvement in formative assessment feedback practices:"I can do it myself.". *Assessment Matters*, *13*, 6-43. https://doi.org/10.18296/am.0036

Huang, C. (2011). Achievement goals and achievement emotions: A meta-analysis. *Educational psychology review*, *23*(3), 359-388. https://doi.org/10.1007/s10648-011-9155-x

Hulleman, C. S., Schrager, S. M., Bodmann, S. M., & Harackiewicz, J. M. (2010). A meta-analytic review of achievement goal measures: Different labels for the same constructs or different constructs with similar labels?. *Psychological bulletin*, *136*(3), 422. https://doi.org/10.1037/a0018947

Hwang, S. (2025). The Interplay of Mindset, Feedback Perception, and Academic Emotion Regulation in Undergraduates' Self-Regulated Writing Ability. *Education Sciences*, *15*(7), 804.https://doi.org/10.3390/educsci15070804

Jacob, R., Hill, H., & Corey, D. (2017). The impact of a professional development program on teachers' mathematical knowledge for teaching, instruction, and student achievement. *Journal of research on educational effectiveness*, *10*(2), 379-407. https://doi.org/10.1080/19345747.2016.1273411

Jacob, S. M. (2012). Mathematical achievement and critical thinking skills in asynchronous discussion forums. *Procedia-Social and Behavioral Sciences*, *31*, 800-804.https://doi.org/10.1016/j.sbspro.2011.12.144

Jacobs, J. E. (1991). Influence of gender stereotypes on parent and child mathematics attitudes. *Journal of Educational psychology*, *83*(4), 518.https://doi.org/10.1037/0022-0663.83.4.518

Jiang, Y., Song, J., Lee, M., & Bong, M. (2017). Self-efficacy and achievement goals as motivational links between perceived contexts and achievement. In *Noncognitive psychological processes and academic achievement* (pp. 102-128). Routledge.https://doi.org/10.1080/01443410.2013.863831

Idrees, M., Crowson, H. M., Andrews, C., & Hennessey, M. N. (2025, April). *Development and validation of mathematics-specific growth mindset scale* [Paper presentation]. American Educational Research Association (AERA) Annual Meeting, Denver, CO, United States.

Kamins, M. L., & Dweck, C. S. (1999). Person versus process praise and criticism: implications for contingent self-worth and coping. *Developmental psychology*, *35*(3), 835. https://doi.org/10.1037/0012-1649.35.3.835

Kamins, M. L., & Dweck, C. S. (1999). Person versus process praise and criticism: implications for contingent self-worth and coping. *Developmental psychology*, *35*(3), 835. https://doi.org/10.1037/0012-1649.35.3.835

Kim, M. S., & Park, S. (2021). Growth of fixed mindset from elementary to middle school: Its relationship with trajectories of academic behavior engagement and academic achievement. *Psychology in the Schools, 58(11), 2175-2188.* https://doi.org/10.1002/pits.22583

Kluger, A. N., & DeNisi, A. (1996). The effects of feedback interventions on performance: a historical review, a meta-analysis, and a preliminary feedback intervention theory. *Psychological bulletin*, *119*(2), 254. https://doi.org/10.1037/0033-2909.119.2.254

Kluger, A. N., & DeNisi, A. (1996). The effects of feedback interventions on performance: a historical review, a meta-analysis, and a preliminary feedback intervention theory. *Psychological bulletin*, *119*(2), 254. https://doi.org/10.1037/0033-2909.119.2.254

Koenka, A. C., Linnenbrink-Garcia, L., Moshontz, H., Atkinson, K. M., Sanchez, C. E., & Cooper, H. (2021). A meta-analysis on the impact of grades and comments on academic motivation and achievement: A case for written feedback. *Educational Psychology*, *41*(7), 922-947. https://doi.org/10.1080/01443410.2019.1659939

Korstange, R., Brinthaupt, T., & Martin, A. (2020). Academic and social expectations of incoming college students. *Journal of College Orientation, Transition, and Retention*, *27*(1). https://doi.org/10.24926/jcotr.v27i1.2334

Kulhavy, R. W. (1977). Feedback in written instruction. *Review of educational research*, *47*(2), 211-232. https://doi.org/10.3102/00346543047002211

Kyaruzi, F., Strijbos, J. W., Ufer, S., & Brown, G. T. (2019). Students' formative assessment perceptions, feedback use and mathematics performance in secondary schools in Tanzania. *Assessment in Education: Principles, Policy & Practice*, *26*(3), 278-302. https://doi.org/10.1080/0969594x.2019.1593103

Laurell, J., Puusepp, I., Hakkarainen, K., & Tirri, K. (2025). Students' cross-domain mindset profiles and academic achievement in Finnish lower-secondary education. *Frontiers in Psychology*, *16*, 1514879. https://doi.org/10.3389/fpsyg.2025.1514879

Lin-Siegler, X., Dweck, C. S., & Cohen, G. L. (2016). Instructional interventions that motivate classroom learning. *Journal of Educational Psychology, 108(3), 295.* https://doi.org/10.1037/edu0000124

Lipnevich, A. A., & Smith, J. K. (2022). Student–feedback interaction model: Revised. *Studies in Educational Evaluation*, *75*, 101208. https://doi.org/10.1016/j.stueduc.2022.101208

Liu, W., & Gumah, B. (2020). How perceived value of feedback influences its impact on self-efficacy. *Social Behavior and Personality: an international journal*, *48*(6), 1-9.https://doi.org/10.2224/sbp.9155

Macnamara, B. N., & Burgoyne, A. P. (2023). Do growth mindset interventions impact students' academic achievement? A systematic review and meta-analysis with recommendations for best practices. *Psychological bulletin*, *149*(3-4), 133.https://doi.org/10.1037/bul0000352

Mandouit, L., & Hattie, J. (2023). Revisiting "The Power of Feedback" from the perspective of the learner. *Learning and Instruction*, *84*, 101718. https://doi.org/10.1016/j.learninstruc.2022.101718

Martínez-Ariza, L., Cudris-Torres, L., Echeverría-King, L. F., & Niño-Vega, J. A. (2022). Influence of motivation on academic performance: an analysis of motivational assessment in mathematics learning. *Revista de Investigación, Desarrollo e Innovación*, *12*(1), 57-66. https://doi.org/10.19053/20278306.v12.n1.2022.14207

Mauri, T., Ginesta, A., & Rochera, M. J. (2016). The use of feedback systems to improve collaborative text writing: a proposal for the higher education context. *Innovations in Education and Teaching International*, *53*(4), 411-423.https://doi.org/10.1080/14703297.2014.961503

McKinney, S. E., Chappell, S., Berry, R. Q., & Hickman, B. T. (2009). An examination of the instructional practices of mathematics teachers in urban schools. *Preventing school failure: Alternative education for children and youth*, *53*(4), 278-284.https://doi.org/10.3200/psfl.53.4.278-284

McKinney, S. E., Chappell, S., Berry, R. Q., & Hickman, B. T. (2009). An examination of the instructional practices of mathematics teachers in urban schools. *Preventing school failure: Alternative education for children and youth*, *53*(4), 278-284. https://doi.org/10.3200/psfl.53.4.278-284

Miller, R. B., DeBacker, T. K., & Greene, B. A. (1999). Perceived instrumentality and academics: The link to task valuing. *Journal of Instructional Psychology*, *26*(4), 250. https://doi.org/10.1006/ceps.1993.1002

Mills, I. M., & Mills, B. S. (2018). Insufficient evidence: Mindset intervention in developmental college math. *Social Psychology of Education*, *21*(5), 1045-1059. https://doi.org/10.1007/s11218-018-9453-y

Mohsenpour, M., Hejazi, E., & Kiamanesh, A. (2008). The Role of Self-Efficacy, Achievement Goals, Learning. *Journal of Educational Innovations, 7(1), 153-172.* https://doi.org/10.1016/j.cedpsych.2007.08.001

Molden, D. C., & Dweck, C. S. (2000). Meaning and motivation. In *Intrinsic and extrinsic motivation* (pp. 131-159). Academic Press. https://doi.org/10.1016/b978-012619070-0/50028-3

Muenks, K., Canning, E. A., LaCosse, J., Green, D. J., Zirkel, S., Garcia, J. A., & Murphy, M. C. (2020). Does my professor think my ability can change? Students' perceptions of their STEM professors' mindset beliefs predict their psychological vulnerability, engagement, and performance in class. *Journal of Experimental Psychology: General*, *149*(11), 2119. https://doi.org/10.1037/xge0000763

Muller, C., & Dweck, C. (1998). Praise for intelligence can undermine children's motivation and performance. *Journal of Personality and Social Psychology*, *75*(1), 33-52.https://doi.org/10.1037/0022-3514.75.1.33

Muthukrishnan, P., Fung Lan, L., Anandhan, H., & Swamy D, P. (2024). The Role of Growth Mindset on the Relationships between Students' Perceptions of English Language Teachers' Feedback and Their ESL Learning Performance. Education Sciences, 14(10), 1073. https://doi.org/10.3390/educsci14101073

Narciss, S. (2004). The impact of informative tutoring feedback and self-efficacy on motivation and achievement in concept learning. *Experimental psychology*, *51*(3), 214-228. https://doi.org/10.1027/1618-3169.51.3.214

Nicholls, J. G., Cheung, P. C., Lauer, J., & Patashnick, M. (1989). Individual differences in academic motivation: Perceived ability, goals, beliefs, and values. *Learning and individual differences*, *1*(1), 63-84. https://doi.org/10.1016/1041-6080(89)90010-1

O'Keefe, P. A., Lee, H. Y., & Chen, P. (2021). Changing students' beliefs about learning can unveil their potential. *Policy Insights from the Behavioral and Brain Sciences*, *8*(1), 84-91.https://doi.org/10.1177/2372732220984173

Pajares, F., & Graham, L. (1999). Self-efficacy, motivation constructs, and mathematics performance of entering middle school students. *Contemporary educational psychology*, *24*(2), 124-139.https://doi.org/10.1006/ceps.1998.0991

Pajares, F., & Miller, M. D. (1994). Role of self-efficacy and self-concept beliefs in mathematical problem solving: A path analysis. *Journal of educational psychology*, *86*(2), 193. https://doi.org/10.1037/0022-0663.86.2.193

Pajares, F., & Miller, M. D. (1997). Mathematics self-efficacy and mathematical problem solving: Implications of using different forms of assessment. *The journal of experimental education*, *65*(3), 213-228. https://doi.org/10.1080/00220973.1997.9943455

Palos, R. (2020). Exploring the impact of achievement goals orientation and study engagement on nursing students' approaches to learning. *Educational Studies*, *46*(2), 205-220. https://doi.org/10.1080/03055698.2018.1555454

Palos, R., Virga, D., & Okros, N. (2024). Why should you believe in yourself? Students' performance-approach goals shape their approach to learning through self-efficacy: A longitudinal analysis. *European Journal of Education*, *59*(2), e12624.https://doi.org/10.1111/ejed.12624

Peixoto, F., Niemivirta, M., & Pipa, J. (2025). Developmental trajectories of achievement goals and achievement in middle school students: Predictors and parallel processes. *Learning and Individual Differences*, *118*, 102619.https://doi.org/10.1016/j.lindif.2024.102619

Price, M., Handley, K., Millar, J., & O'donovan, B. (2010). Feedback: all that effort, but what is the effect?. *Assessment & Evaluation in Higher Education*, *35*(3), 277-289. https://doi.org/10.1080/02602930903541007

Price, M., Handley, K., O'Donovan, B., Rust, C., & Millar, J. (2013). Assessment feedback: An agenda for change. In *Reconceptualising feedback in higher education* (pp. 41-53). Routledge.https://doi.org/10.1080/02602938.2015.1052774

Rakoczy, K., Harks, B., Klieme, E., Blum, W., & Hochweber, J. (2013). Written feedback in mathematics: Mediated by students' perception, moderated by goal orientation. *Learning and Instruction*, *27*, 63-73. https://doi.org/10.1016/j.learninstruc.2013.03.002

Ramirez, G., Hooper, S. Y., Kersting, N. B., Ferguson, R., & Yeager, D. (2018). Teacher math anxiety relates to adolescent students' math achievement. *AERA open*, *4*(1), 2332858418756052. https://doi.org/10.1177/2332858418756052

Rattan, A., Good, C., & Dweck, C. S. (2012). "It's ok—Not everyone can be good at math": Instructors with an entity theory comfort (and demotivate) students. *Journal of experimental social psychology*, *48*(3), 731-737. https://doi.org/10.1016/j.jesp.2011.12.012

Robinson, P., & Bond, C. (2025). A systematic literature review of teachers' beliefs about intelligence and mindset and the potential impact on their practice. *Educational Psychology in Practice*, *41*(2), 150-165. https://doi.org/10.1080/02667363.2024.2444601

Roels, P., Van Roosmalen, G., & Van Soom, C. (2010). Adaptive feedback and student behaviour in computer-assisted instruction. *Medical education*, *44*(12), 1185-1193. https://doi.org/10.1111/j.1365-2923.2010.03784.x

Rothrock, K. S., & Gay, A. S. (2025). What college freshmen believe about themselves: An investigation of mathematical mindset, identity, self-efficacy, and use of self-regulated learning strategies in mathematics. *International Journal of Research in Undergraduate Mathematics Education*, *11*(2), 187-216. https://doi.org/10.1007/s40753-023-00229-9

Ruegg, R. (2018). The effect of peer and teacher feedback on changes in EFL students' writing self-efficacy. *The Language Learning Journal*, *46*(2), 87-102. https://doi.org/10.1080/09571736.2014.958190

Schoenfeld, A. H. (2016). Learning to think mathematically: Problem solving, metacognition, and sense making in mathematics (Reprint). *Journal of education*, *196*(2), 1-38. https://doi.org/10.1177/002205741619600202

Schunk, D. H. (2003). Self-efficacy for reading and writing: Influence of modeling, goal setting, and self-evaluation. *Reading &Writing Quarterly*, *19*(2), 159-172. https://doi.org/10.1080/10573560308219

Schunk, D. H. (2012). Theory and research on student perceptions in the classroom. In *Student perceptions in the classroom* (pp. 3-24). Routledge. https://doi.org/10.4324/9780203052532-5

Schunk, D. H., & DiBenedetto, M. K. (2016). Self-efficacy theory in education. In *Handbook of motivation at school* (pp. 34-54). Routledge. https://doi.org/10.4324/9781315773384-9

Schwinger, M., Steinmayr, R., & Spinath, B. (2016). Achievement goal profiles in elementary school: Antecedents, consequences, and longitudinal trajectories. *Contemporary educational psychology*, *46*, 164-179.https://doi.org/10.1016/j.cedpsych.2016.05.006

Scott, M. J., & Ghinea, G. (2013). On the domain-specificity of mindsets: The relationship between aptitude beliefs and programming practice. *IEEE Transactions on Education*, *57*(3), 169-174. https://doi.org/10.1109/te.2013.2288700

Senko, C., Hulleman, C. S., & Harackiewicz, J. M. (2011). Achievement goal theory at the crossroads: Old controversies, current challenges, and new directions. *Educational psychologist*, *46*(1), 26-47. https://doi.org/10.1080/00461520.2011.538646

Sheffler, P., & Cheung, C. S. (2024). Effects of mothers' mindset and perceived child competence on their learning involvement. *The Journal of Experimental Education, 92(1), 101-119.* https://doi.org/10.1080/00220973.2022.2137096

Shute, V. J. (2008). Focus on formative feedback. *Review of educational research*, *78*(1), 153-189. https://doi.org/10.3102/0034654307313795

Sisk, V. F., Burgoyne, A. P., Sun, J., Butler, J. L., & Macnamara, B. N. (2018). To what extent and under which circumstances are growth mind-sets important to academic achievement? Two meta-analyses. *Psychological science*, *29*(4), 549-571. https://doi.org/10.1177/0956797617739704

Smit, R., Dober, H., Hess, K., Bachmann, P., & Birri, T. (2023). Supporting primary students' mathematical reasoning practice: the effects of formative feedback and the mediating role of self-efficacy. *Research in Mathematics Education*, *25*(3), 277-300. https://doi.org/10.1080/14794802.2022.2062780

Smith, E. C., Starratt, G. K., McCrink, C. L., & Whitford, H. (2020). Teacher evaluation feedback and instructional practice self-efficacy in secondary school teachers. *Educational Administration Quarterly*, *56*(4), 671-701. https://doi.org/10.1177/0013161x19888568

Strijbos, J. W., Narciss, S., & Dünnebier, K. (2010). Peer feedback content and sender's competence level in academic writing revision tasks: Are they critical for feedback perceptions and efficiency?. *Learning and instruction*, *20*(4), 291-303.https://doi.org/10.1016/j.learninstruc.2009.08.008

Takehashi, H., Toyosawa, J., Shimai, S., & Yananose, M. (2024). A study of the conceptual structure of growth mindsets and their impact on self-improvement motivation. *Japanese Psychological Research*, *66*(2), 166-177. https://doi.org/10.1111/jpr.12469

Tanner, H., & Jones, S. (2003). Self-Efficacy in Mathematics and Students' Use of Self-Regulated Learning Strategies during Assessment Events. *International Group for the Psychology of Mathematics Education*, *4*, 275-282.

Thurlings, M., Vermeulen, M., Bastiaens, T., & Stijnen, S. (2013). Understanding feedback: A learning theory perspective. *Educational Research Review*, *9*, 1-15. https://doi.org/10.1016/j.edurev.2012.11.004

Truax, M. L. (2018). The impact of teacher language and growth mindset feedback on writing motivation. *Literacy Research and Instruction*, *57*(2), 135-157. https://doi.org/10.1080/19388071.2017.1340529

Umemoto, T., & Inagaki, T. (2023). Relationships Between Achievement Goals, Motivation Instability, and Learning Persistence in Asynchronous Distance Classes. S*age Open, 13(4), 21582440231219075*. https://doi.org/10.1177/21582440231219075

Van der Kleij, F. M., Adie, L. E., & Cumming, J. J. (2019). A meta-review of the student role in feedback. *International Journal of Educational Research*, *98*, 303-323.https://doi.org/10.1016/j.ijer.2019.09.005

Walker, C. O., & Greene, B. A. (2009). The relations between student motivational beliefs and cognitive engagement in high school. *The Journal of Educational Research*, *102*(6), 463-472.https://doi.org/10.3200/joer.102.6.463-472

Wang, Z., Lukowski, S. L., Hart, S. A., Lyons, I. M., Thompson, L. A., Kovas, Y., ... & Petrill, S. A. (2015). Is math anxiety always bad for math learning? The role of math motivation. *Psychological science*, *26*(12), 1863-1876.https://doi.org/10.1177/0956797615602471

Wigfield, A., & Eccles, J. S. (2002). The development of competence beliefs, expectancies for success, and achievement values from childhood through adolescence. *Development of achievement motivation*, 91-120. https://doi.org/10.1016/b978-012750053-9/50006-1

Wiggins, G. (2012). Seven keys to effective feedback. *Feedback*, *70*(1), 10-16.

Winstone, N. E., Nash, R. A., Parker, M., & Rowntree, J. (2017). Supporting learners' agentic engagement with feedback: A systematic review and a taxonomy of recipience processes. *Educational psychologist*, *52*(1), 17-37.https://doi.org/10.1080/00461520.2016.1207538

Wisniewski, B., Zierer, K., & Hattie, J. (2020). The power of feedback revisited: A meta-analysis of educational feedback research. *Frontiers in psychology*, *10*, 487662. https://doi.org/10.3389/fpsyg.2019.03087

Witter, M., & Hattie, J. (2024). Can teacher quality be profiled? A cluster analysis of teachers' beliefs, practices and students' perceptions of effectiveness. *British Educational Research Journal*, *50*(2), 653-675.https://doi.org/10.1002/berj.3938

Xie, F., Yang, Y., & Xiao, C. (2023). Gender-math stereotypes and mathematical performance: the role of attitude toward mathematics and math self-concept. *European Journal of Psychology of Education*, *38*(2), 695-708. https://doi.org/10.1007/s10212-022-00631-y

Yeager, D. S., & Dweck, C. S. (2012). Mindsets that promote resilience: When students believe that personal characteristics can be developed. *Educational psychologist*, *47*(4), 302-314.https://doi.org/10.1080/00461520.2012.722805

Yeager, D. S., Hanselman, P., Walton, G. M., Murray, J. S., Crosnoe, R., Muller, C., ... & Dweck, C. S. (2019). A national experiment reveals where a growth mindset improves achievement. *Nature*, *573*(7774), 364-369.https://doi.org/10.1038/s41586-019-1466-y

Yin, Y., Shavelson, R. J., Ayala, C. C., Ruiz-Primo, M. A., Brandon, P. R., Furtak, E. M., ... & Young, D. B. (2008). On the impact of formative assessment on student motivation, achievement, and conceptual change. *Applied measurement in Education*, *21*(4), 335-359. https://doi.org/10.1080/08957340802347845

Yu, J., & McLellan, R. (2020). Same mindset, different goals and motivational frameworks: Profiles of mindset-based meaning systems. *Contemporary Educational Psychology*, *62*, 101901. https://doi.org/10.1016/j.cedpsych.2020.101901

Zedan, R. (2021). Student feedback as a predictor of learning motivation, academic achievement and classroom climate. *Education and self-development*, *16*(2), 27-46. https://doi.org/10.26907/esd.16.2.03

Zhao, W., Shi, X., Jin, M., Li, Y., Liang, C., Ji, Y., ... & Tian, Y. (2024). The impact of a growth mindset on high school students' learning subjective well-being: The serial mediation role of achievement motivation and grit. *Frontiers in Psychology, 15, 1399343*. https://doi.org/10.3389/fpsyg.2024.1399343

Appendix A
Math Growth Mindset Scale (Dweck, 2006)

Scoring= 6-point Likert scale ranging from 1-strongly disagree, 2-disagree, 3-mostly disagree, 4-mostly agree, 5-agree, and 6-strongly agree.

Items	**Scoring Range**
1- You have a certain amount of intelligence in mathematics, and you really can't do much to change it.	1 2 3 4 5 6
2- Our intelligence in mathematics is something personal that you cannot change very much.	1 2 3 4 5 6
3- No matter who you are, you can significantly change your level of intelligence in mathematics.	1 2 3 4 5 6
4- To be honest, you can't really change how intelligent you are in mathematics.	1 2 3 4 5 6
5- You can always substantially change how intelligent you are in mathematics.	1 2 3 4 5 6
6- You can learn new things, but you cannot really change your basic intelligence in mathematics.	1 2 3 4 5 6
7- No matter how intelligent you are in mathematics, you can always change it quite a bit.	1 2 3 4 5 6
8- You can change your basic intelligence level in mathematics considerably.	1 2 3 4 5 6

Appendix B
Approaches to Learning Scale (DeBacker & Crowson, 2006)

Scoring= 6-point Likert scale ranging from 1-strongly disagree, 2-disagree, 3-mostly disagree, 4-mostly agree, 5-agree, and 6-strongly agree.

Items	**Scoring Range**
Mastery/Learning Goals	1 2 3 4 5 6
1- I do my work in this class because I want to understand the ideas	1 2 3 4 5 6
7- I do my work in this class because I like learning things	1 2 3 4 5 6
17**-** I do my work in this class because I like to understand what I am learning	1 2 3 4 5 6
18- I do my work in this class because I want to learn new things	1 2 3 4 5 6
30- I do my work in this class because I like the challenge of learning new things	1 2 3 4 5 6
35- I do my work in this class because I want to understand it really well	1 2 3 4 5 6
Performance Approach Goals	
3- I do my work in this class because I like to perform better than other students	1 2 3 4 5 6
10- I do my work in this class because I want to look smart to my friends	1 2 3 4 5 6
14- I do my work in this class because I can show other people that I'm smart	1 2 3 4 5 6
19- I do the work in this class because I like to show others that the work is easy for me	1 2 3 4 5 6
32- I do my work in this class because I like to score higher than the other students	1 2 3 4 5 6
Performance Avoidance Goals	
6- I don't do the work in this class so others won't realize I don't understand	1 2 3 4 5 6

16- I don’t do my work in this class so I can avoid looking stupid to others	1 2 3 4 5 6
22- I don’t do the work in this class so no one will know I’m having trouble with it	1 2 3 4 5 6
23- I do my work in this class because I don't want to be the only one who can't do the work well	1 2 3 4 5 6
26- I do my work in this class because I don't want to look dumb to my classmates or teachers	1 2 3 4 5 6
38- I do my work in this class because I don’t want to be embarrassed about not being able to do the work	1 2 3 4 5 6
Self-Efficacy	
2- I can do the work in this class	1 2 3 4 5 6
9- I don't understand the ideas in this class very well	1 2 3 4 5 6
13- Next year in this subject I will probably have trouble understanding the ideas	1 2 3 4 5 6
24- Compared with other students in this class, I think I am doing well	1 2 3 4 5 6
28- Compared with other students I don't know very much about this class	1 2 3 4 5 6
31- I understand the ideas in this class	1 2 3 4 5 6
36- I am doing well in this class compared to others	1 2 3 4 5 6

Appendix C
Perceived Effective Feedback Questionnaire (Carvalho et al., 2014)

Scoring = 5-point Likert scale, ranging from 1-It never happens in this class, "5- It always happens in this class"

Items	**Scoring Range**
1- The teacher explains what is expected to learn in the course	12 3 4 5
2- The forms of assessment in the course are presented clearly	12 3 4 5
3- The teacher makes comments to help us complete assignments	12 3 4 5
4- The teacher gives us opportunities to improve our work / grades	12 3 4 5
5- The assessment grades are communicated and explained to students	12 3 4 5
6- Different forms of assessment are used (not only written tests)	12 3 4 5
7- After we complete an assignment, correct answers and/or suggestions to improve are provided	12 3 4 5
8- The teacher asks questions that help us to reflect on the quality of our work	12 3 4 5

Appendix D

Recruitment Material/Script

Greetings. I am Maria Idrees, and I am a graduate student (under the supervision of Dr. Mike Crowson) in the Department of Educational Psychology. I am collecting data for my dissertation project. I invite you to participate in my research project entitled Feedback perceptions, mindset/ability beliefs, and achievement goals among math students. I am emailing to ask if you would be willing to take no more than 30 minutes to complete a survey for this research project. Participation is completely voluntary, and your survey answers will remain strictly confidential. By participating in this study, you will have the opportunity to earn extra grades for (MATH 1643) and credits equal to one of your assigned assignments for (MATH 1005) participants. If you choose not to participate in the study, you will not be penalized. If you desire to participate in the study, please follow the link below and complete the survey outside of class by November 28, 2025.

Appendix E

Informed Consent

I am Maria Idrees, and I am a graduate student (under the supervision of Dr. Mike Crowson) in the Department of Educational Psychology. I am collecting data for my dissertation project. I invite you to participate in my research project entitled Feedback perceptions, mindset/ability beliefs, and achievement goals among math students. This research is being conducted within undergraduate MATH courses (MATH 1005– Mathematical Reasoning and MATH 1643– Functions and Modeling for Business, Life and Social Sciences) from the Department of Mathematics, University of Oklahoma. You were selected as a possible participant because of your enrollment within the course. You must be at least 18 years of age to participate in this study. Please read this document and contact either of us if you have any questions BEFORE agreeing to take part in my research.

What is the purpose of this research? The purpose of this research is to investigate the difference between general vs. specific growth mindset scale on students' learning outcomes.

How many participants will be in this research? About 2000 people will take part in this research.

What will I be asked to do? If you agree to be in this research, you will answer your level of agreement with statements concerning your beliefs about learning, approaches to learning, and your need for satisfaction in math classes.

Will I be compensated for participating? Students enrolled in MATH 1643 will receive 5 points of extra credit, and students in MATH 1005 will receive credit equivalent to one course assignment, as determined by your instructor. Your instructor has confirmed that you will receive bonus points for your participation in this study.

How long will this take? Your participation will not take more than 30 minutes.

What are the risks and/or benefits if I participate? There is a risk of accidental release of data and breach of confidentiality. The risk of accidental data release or breach of confidentiality is extremely low, as would be the likely severity if this occurs. There is a risk that the demographic information you provide could be connected with your personal identity or academic records through deductive re-identification, even after all explicit identifiers in your data are removed. This risk, however, is low given the large number of participants we are expecting and the high generality of the demographic questions posed in the survey.

Who will see my information? In research reports, there will be no information that will make it possible to identify you. Research records will be stored securely, and only approved researchers and the OU Institutional Review Board will have access to the records. Data is collected via an online survey system that has its own privacy and security policies for keeping your information confidential. Please note no assurance can be made as to the use of the data you provide for purposes other than this research. After removing all identifiers, we might share your data with other researchers or use it in future research without obtaining additional consent from you.

Will my records be accessed? NO

Do I have to participate? No. If you do not participate, you will not be penalized or lose benefits or services unrelated to the research. If you decide to participate, you don't have to answer any question and can stop participating at any time.

Who do I contact with questions, concerns or complaints? If you have any questions about this research project, please contact Maria Idrees (principal investigator at 405/6207415, maria.idrees-1@ou.edu) or Dr. Mike Crowson (her faculty advisor at mcrowson@ou.edu).

Questions about your rights as a research participant or concerns about the project should be directed to the Institutional Review Board at The University of Oklahoma-Norman campus at 405/325-8110 or irb@ou.edu. By clicking the arrow button at the bottom of this page, you are agreeing to take part in the study described above and will be moved to the first question. If you do not agree to participate, simply close out your browser. If at any time in the survey you choose not to participate, please close out your browser. Thank you for your consideration. This research has been approved by the University of Oklahoma, Norman Campus IRB. IRB Number: 18949 Approval date: 09/23/2025.